DEMONSTRATION REPORT

Demonstration Report for Geonics EM-63 Cued-Interrogation Data Collection, Processing and Archiving at Camp Sibert, Alabama

ESTCP Project MM-0504

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14. ABSTRACT

This report describes the data collection, processing and archiving of Geonics EM-63 time-domain electromagnetic data over selected anomalies within Site 18 of the Camp Sibert FUDS) In May 2007, cued-interrogation data were collected over 200 anomalies in a blind-test scenario and 38 items in a GPO. The cued-data were collected dynamically along 11 North-South lines spaced 30 cm apart, 3 East-West lines spaced 50 cm apart and on two "pitch" lines directly over the anomaly center. The pitch lines involved collecting data while the EM-63 was pitched backwards and then forwards over the anomaly. In addition to the cued-interrogation, full-coverage data at 0.5 m spacing were collected over the GPO and a 35 m by 60 m area of the blind site. In this demonstration report we evaluate six identified performance metrics for the technology including reliability/robustness, data density, survey rate, percentage of site covered, and position and depth accuracy of inverted positions. Metrics more directly related to discrimination performance are assessed in a separate demonstration report that addresses data processing and interpretation.

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EXECUTIVE SUMMARY

This demonstration report describes the data collection, processing and archiving of Geonics EM-63 time-domain electromagnetic data over selected anomalies within Site 18 of the Camp Sibert Formerly Used Defense Site (FUDS). A Leica TPS 1206 Robotic Total Station (RTS) was used for positioning and a Crossbow AHRS 400 Inertial Motion Unit (IMU) for sensor orientation. The primary munition or explosive of concern (MEC) on the site is a 4.2" mortar. Cued-interrogation data were collected over 200 anomalies in a blind-test scenario and 38 items in a geophysical prove-out (GPO). The cued-data were collected dynamically along 11 North-South lines spaced 30 cm apart, 3 East-West lines spaced 50 cm apart and on two "pitch" lines directly over the anomaly center. The pitch lines involved collecting data while the EM-63 was pitched backwards and then forwards over the anomaly. In addition to the cued-interrogation, full-coverage data at 0.5 m spacing were collected over the GPO and a 35 m by 60 m area of the blind site.

The data collection was conducted over an 11 day period in May 2007. There were no significant issues that effected the quality or time-required to collect the data. The main issue that needed to be resolved post-survey concerned the RTS set-ups in the South-West and GPO sections of the site. The provided location of one monument was incorrect, and the location of another monument was erroneously entered into the RTS. These problems were resolved by appropriate translations and rotations of the RTS positions. Only one anomaly failed QC post-survey due to drift in the pitch and roll measurements returned by the IMU.

In this demonstration report we evaluate six identified performance metrics for the technology including reliability/robustness, data density, survey rate, percentage of site covered, and position and depth accuracy of inverted positions. Metrics more directly related to discrimination performance are assessed in a separate demonstration report that addresses data processing and interpretation.

The demonstration was conducted under project ESTCP MM-0504 "Practical Discrimination Strategies for Application to Live Sites" as part of the wider ESTCP Discrimination Study Pilot Project.

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ACRONYMS

A	Amperes
AGL	Above Ground Level
ASR	Archive Search Report
CERF	Brand name for PXA255 microprocessor
cm	centimeter
COTS	Commercial Off The Shelf
DAS	Data Acquisition System
Db	Decibels
DMU	Data Management Unit
EM	Electromagnetic
ERDC	Engineer Research and Development Center
ESTCP	Environmental Security Technology Certification Program
FLBGR	Former Lowry Bombing and Gunnery Range
FPGA	Field Programmable Gate Array
FUDS	Formerly Used Defense Sites
GPO	Geophysical Prove Out
GPS	Global Positioning System
HE	High Explosive
Hz	Hertz
IMU	Inertial Motion Unit
m	meter
MEC	Munitions and Explosives of Concern
MR	Munitions Response
ms	Millisecond
µs	Microsecond
NAD	North American Datum
P_d	Probability of Detection
PI	Principal Investigator
ppm	parts per million
PPS	Pulse Per Second
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RMS	Root Mean Square
RTC	Replacement Training Center
RTS	Robotic Total Station
RTK GPS	Real-time Kinematic Global Positioning System
SNR	Signal to Noise Ratio
TEU	Technical Escort Unit
US	United States
USACE	United States Army Corps of Engineers
UTC	Unit Training Center
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
WP	White-phosphorous

1. INTRODUCTION

1.1 Background

The FY06 Defense Appropriation contains funding for the "Development of Advanced, Sophisticated, Discrimination Technologies for UXO Cleanup" in the Environmental Security Technology Certification Program (ESTCP). In 2003, the Defense Science Board observed: "The … problem is that instruments that can detect the buried unexploded ordnance (UXO) also detect numerous scrap metal objects and other artifacts, which leads to an enormous amount of expensive digging. Typically 100 holes may be dug before a real UXO is unearthed! The Task Force assessment is that much of this wasteful digging can be eliminated by the use of more advanced technology instruments that exploit modern digital processing and advanced multi-mode sensors to achieve an improved level of discrimination of scrap from UXO."

Significant progress has been made in discrimination technology. To date, testing of these approaches has been primarily limited to test sites, with only limited application at live sites. Acceptance of discrimination technologies requires demonstration of system capabilities at real UXO sites under real world conditions. Any attempt to declare detected anomalies to be harmless and requiring no further investigation will require demonstration to regulators of not only individual technologies, but an entire decision making process. This discrimination study will be the first phase in what is expected to be a continuing effort that will span several years.

1.2 Objectives of the Demonstration

1.2.1 Objectives of the ESTCP UXO Discrimination Study

As outlined in the Environmental Security Technology Certification Program Unexploded Ordnance Discrimination Study Demonstration Plan (ESTCP, 2007), the objectives of the study are twofold. First, the study is designed to test and validate UXO detection and discrimination capabilities of currently available and emerging technologies on real sites under operational conditions. Second, the ESTCP Program Office and their demonstrators are investigating, in cooperation with regulators and program managers, how UXO discrimination technologies can be implemented in cleanup operations.

Within each of these two overarching objectives, there are several sub-objectives.

1.2.2 Technical objectives of the Discrimination Study

The study is designed to test and evaluate the capabilities of various UXO discrimination processes which each consist of selected sensor hardware, a survey mode, and a software-based processing step. These advanced methods will be compared to existing practices and will validate the pilot technologies for the following:

- Detection of UXO
- Identification of features that can help distinguish scrap and other clutter from UXO
- Reduction of false alarms (items that could be safely left in the ground that are incorrectly classified as UXO) while maintaining probabilities of detection (P_ds) acceptable to all
- Quantify the cost and time impact of advanced methods on the overall cleanup process as compared to existing practices

Additionally, the study aims to understand the applicability and limitations of the selected technologies in the context of project objectives, site characteristics, and suspected ordnance contamination. Sources of uncertainty in the discrimination process will be identified and their impact quantified to support decision making. This includes issues such as impact of data quality due to how the data are collected. The process for making the dig-no dig decision process will be explored. Potential quality assurance/quality control (QA/QC) processes for discrimination also will be explored. Finally, high-quality, well documented data will be collected to support the next generation of signal processing research.

1.3 Regulatory Drivers and Stakeholder Issues

ESTCP has assembled an Advisory Group to address the regulatory, programmatic, and stakeholder acceptance issues associated with the implementation of discrimination in the Munitions Response (MR) process.

1.3.1 Objective Of The Advisory Group

The advisory group will focus on exploring UXO discrimination processes that will be useful to regulators and site managers in making decisions by determining:

- What information is required to support a discrimination decision?
  - What data are needed to support decisions, particularly with regard to decisions not to dig all detected anomalies?
  - Necessary end-products to support discrimination decisions
  - What are the site specific factors that impact this process?
  - How best can the information be presented?
- What must be demonstrated for the community to consider not digging every anomaly as a viable alternative?
  - Methodology
  - Transparency
  - QA/QC requirements
  - Validation
- For implementation beyond the pilot project, how should proposals to implement discrimination be evaluated?

In support of the above objective, the advisory group will provide input and guidance to the Program Office on the following topics:

- Pilot project objectives and flow-down to performance metrics
- Flow down of program objectives to data quality objectives
- Demonstration / data collection plans
- QA/QC requirements and documentation
- Interpretation, analysis, and validation
- Process flow for discrimination-based removal actions
- What does it all mean?

1.3.2 Specific Objectives of the Demonstration

The demonstration objective is to determine the discrimination capability, cost, and reliability of the Geonics EM-63 time-domain metal detector when deployed in a cued-interrogation mode. Sky Research Inc performed cued-interrogation of selected anomalies within Site 18 of the Camp Sibert Formerly Used Defense Site (FUDS) using an EM-63 mounted on an air-suspension cart with Crossbow Inertial Motion Unit (IMU) for orientation. A Leica TPS 1206 Robotic Total Station (RTS) was used for positioning.

2. TECHNOLOGY DESCRIPTION

Magnetic and electromagnetic methods represent the main sensor types used for detection of UXO. Magnetic and electromagnetic (EM) phenomenologies have different strengths and weaknesses. Magnetic data (specifically for cesium vapor total-field magnetometers) are simpler to collect, are mostly immune to sensor orientation and are better able to detect deeper targets. EM data are sensitive to non-ferrous metals, are better at detecting smaller items and are able to be used in areas with magnetic geology. The reason for including the Geonics EM-63 cart system in this demonstration is because the information content of the data is much richer than that of the industry standard EM-61 (26 time gates versus 4). With the additional information available at each sounding, the discrimination performance of the EM-63 will be superior to that of the EM-61 with equivalent signal to noise ratio (SNR) and position and orientation uncertainties.

2.1 Technology Development and Application

Over the last 2 years we have made significant advances in our EM-63 data collection systems, including incorporation of an IMU and suspension system; and upgrade to the latest Leica Robotic Total Station (RTS, model TPS 1206). These improvements, funded through our ERDC Congressional-set-aside project and our own internal resources, have been thoroughly tested and were used extensively over a three week period in February/March 2006 at our Ashland test-site, the Marine-Corps Base Camp Lejeune, and in the first phase of this project for the data collection component of the Former Lowry Bombing and Gunnery Range (FLBGR) demonstration. The results for the FLBGR deployment of this system are reported in "*Demonstration Report for the Former Lowry Gunnery and Bombing Range, Project 200504 Practical Discrimination Strategies for Application to Live Sites"* (Billings *et. al*., 2007a). Participation in this study will further test the system under different site conditions. Table 1 summarizes the components of the Sky Research EM-63 survey system. More details on specific system components are provided in the text that follows.

2.1.1 Geonics EM-63 Time-Domain Metal Detector

The Geonics EM-63 is a pulse based, multi-channel time domain electromagnetic induction instrument. The system consists of a 1 m x 1 m square transmitter coil and three coaxial 0.5 m x 0.5 m square receiver loops mounted on a two-wheel trailer. Measured voltages are averaged over 26 geometrically spaced time gates, spanning the range 180 μs to 25.14 milliseconds (ms). Sky Research's custom modified EM-63 cart was used for this demonstration. The cart places the EM-63 coil at 25 cm above the ground, which is lower than the standard 40cm. It also has an air suspension system that will minimize rapid changes in coil orientation. A Leica TPS 1206 RTS and the Crossbow AHRS 400 IMU were used for measuring the position/orientation of the cart. The system was used extensively in 2006 at the FLBGR, Colorado, at our Ashland test-site (Figure 1), and at the Marine-Corps Base Camp Lejeune.

Table 1. Components of the Sky Research EM-63 survey system

Technology/Equipment	Description	Features
Geonics EM-63 Cart	• Multi-channel time-domain EM induction instrument • 1 x 1 m transmitter coil and 3 - 0.5 m^2 coaxial receiver loops mounted on a 2 wheel trailer • Leica RTS or Trimble Global Positioning System (GPS) • Crossbow AHRS 400 IMU	• 26 geometrically spaced time gates • EM-63 coil mounted 25 centimeters (cm) above ground level (AGL) • Air suspension system to moderate rapid terrain changes
Positioning System (RTS)	• Leica RTS TPS1206 • High-precision total station system, tracks prism 360 degrees up to 1000 m	• 3-D position solutions up to 8 hertz (Hz) • Sub-centimeter accuracy • Robotic capability tracks system in motion
Orientation Sensors	• Crossbow AHRS-400 IMU	• Measures pitch, roll, and yaw • Nine-axis measurement system for complete measurement of system dynamics • Successive RTS measurements needed to estimate azimuth • Zero-velocity update every 10 minutes to recalibrate pitch and roll outputs
Data Acquisition System (DAS)	• Sky Research Inc. Hardware DAS • Comprises an FPGA, Linux CERF cube and Tablet PC	• Time-stamp up to 8 serial inputs with 10 (micro second) μs precision • 1 pulse per second (PPS) pulse used to synchronize clock with GPS
Cued-interrogation Strategy	• Dynamic data collection along parallel transects marked on a tarp • Pitch measurements on two perpendicular lines	• 3 meter (m) x 3 m survey area • Samples every 10 cm along line, 30 cm across line and 3 perpendicular lines at 50 cm spacing. • Sensor pitched forwards and backwards over anomaly center.

Figure 1. Modified EM-63 cart collecting discrimination mode data at the Ashland test-site. Positional errors are minimized By minimizing the level-arm between the RTS prism and the coil and including the IMU for orientation.

2.1.2 Positioning System: Leica TPS 1260 Robotic Total Station

Leica recently introduced the TPS1200 series as the most advanced commercially available RTS system. The Leica RTS system (Figure 2) provides 3-D position solutions at a rate of up to 8 Hz with sub-cm accuracy. The system operates as a high-precision total station and defines the position of a 360-degree prism to a distance of approximately 1000 m. The robotic component of the system is the ability of the RTS to track the prism while it is moving. Operationally, the total station is located over a known point in proximity of the survey area, and a second point is utilized to establish a survey baseline. Once established, the RTS can track the prism while it is deployed on the geophysical survey platform. One disadvantage of the RTS is that it does not have an equivalent of the GPS 1 pulse-per-second (PPS) that can be used to discipline the clock on the DAS. In addition, our experience with the RTS indicates that any latencies (delay between when a measurement is taken and then reported) can be variable. This can limit the positional accuracy of the geophysical sensor data.

Figure 2. Sky Research utilizes the Leica RTS TPS1206 laser positioning system. This device is set up in over a known point and tracks a prism attached to the geophysical survey equipment.

2.1.2.1 Orientation Sensors

The Crossbow AHRS-400 IMU was used for measuring the pitch, roll and yaw of the EM-63 cart. The AHRS-series units are low power, fast turn on, reliable, and accurate solutions for geophysical survey applications. The AHRS-400 series of products utilizes a sophisticated Kalman filter algorithm to allow the unit to track orientation accurately through dynamic maneuvers and will automatically adjust for changing dynamic conditions without any external user input. The AHRS is the solid-state equivalent of a vertical gyro/artificial horizon display combined with a directional gyro. The AHRS is a nine-axis measurement system that combines linear accelerometers, rotational rate sensors, and magnetometers. The AHRS uses the 3-axis accelerometer and 3-axis rate sensor to make a complete measurement of the dynamics of the system. The addition of a 3-axis magnetometer also allows the AHRS to make a true measurement of magnetic heading. For the EM-63 system, the Crossbow is within approximately 0.5 meters of the transmitter coils and the heading output is unreliable. Consequently, successive RTS or GPS measurements will be used to estimate the azimuth (yaw).

Crossbow Technology Data Management Units (DMUs) employ onboard digital processing to compensate for deterministic error sources within the unit and to compute attitude information. The DMUs accomplish these tasks with an analog-to-digital converter and a high performance Digital Signal Processor.

Our previous experience with the Crossbow demonstrated that the pitch and roll outputs do not drift appreciably over time-scales on the order of tens of minutes. To ensure that the pitch and roll outputs are accurate, we performed a zero-velocity update once every ten minutes. In this process, the system was held stationary for 30 seconds, allowing the unit to recalibrate.

2.1.3 Data Acquisition System

Sky Research's Hardware data acquisition system (DAS) (Figure 3) was used to control, log and time-stamp the sensor data. This DAS is used extensively within Sky Research's helicopter based magnetometer system. The DAS is designed around a field programmable gate array (FPGA) logic device and a low-power high-speed PXA255 microprocessor running the Linux operating system and referred to as the CERF. The FPGA has the ability to time stamp all incoming instrument data to a relative accuracy of 10μS, and an absolute time accuracy of the same precision when connected to a GPS receiver with a PPS output.

A photograph of the electronics in the DAS is shown on the left in Figure 3, and consists of three boards. The top board contains the re-programmable FPGA, the power conditioning circuitry (left) and RS-232 and RS422 circuitry (on the right). The board shown in the middle is the CERF single board computer running at 400 MHz. The board shown at the bottom is a custom design for converting up to 8 sine wave outputs from magnetometers to square wave signals using zero crossing detection (these were not used for this application).

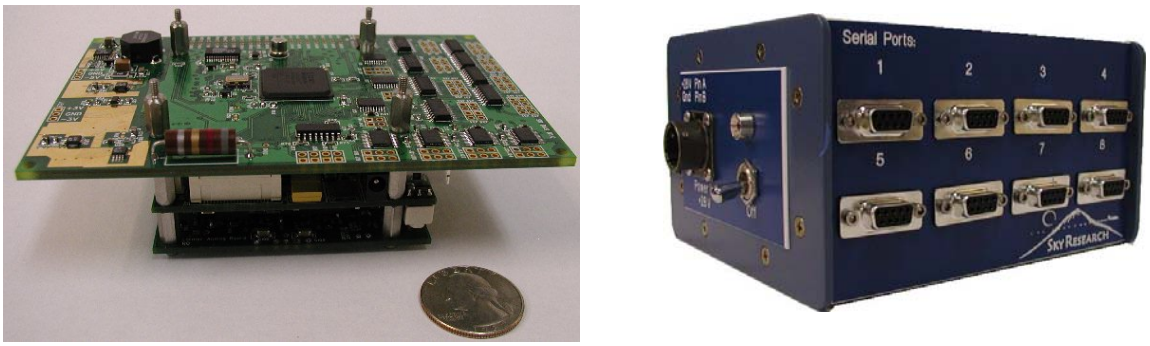

Figure 3. The DAS printed circuit boards and a view of the enclosure for a DAS configured to accept 8 serial inputs.

The DAS is controlled by a separate Tablet PC running Windows XP that is connected to the CERF by an Ethernet cable. The Tablet PC controls data logging, inserts line-markers into the sensor files, displays the status of each instrument, provides strip-charts of each sensor and stores all data onto disc.

Previous deployments of the Sky Research EM-63 sensor system have utilized a different software based DAS that relies on the Windows operating system for time-stamps. These time-stamps have a low precision (on the order of 20 ms or greater) and can be unreliable. In addition, events are placed in a queue and are time-tagged sequentially, unlike the FPGA where time-tags can be generated in parallel at 10 μs precision.

2.1.4 Cued-interrogation Procedure

The cued-interrogation procedure consists of surveying a 3 square meter area over a pre-identified location. We used a 3 meter by 2 meter tarpaulin with lanes marked at 30 cm spacing in the N-S direction (Figure 4). Data were collected by pushing the EM-63 along each marked lane at a speed of no greater than 0.4 m/s. At this rate of data collection, one sounding was collected every 10 cm along each line. Three lines at 0.5 m spacing were also collected in the East-West direction. In addition, two “pitch-lines” were collected. The first was with the cart over the center of the anomaly facing North, the second with it facing East. The cart was pitched backwards as far as possible before data collection commenced, then it was tipped slowly forward as far as possible in the forward direction.

The EM-63 cued-interrogation survey required a crew of three, which included an experienced geophysicist and two field workers. Two crew members operated the EM-63, while the third person located the next anomaly, set up and packed up the tarpaulin, etc.

The standardization and calibration tests described in Appendix A were conducted during each day of surveying.

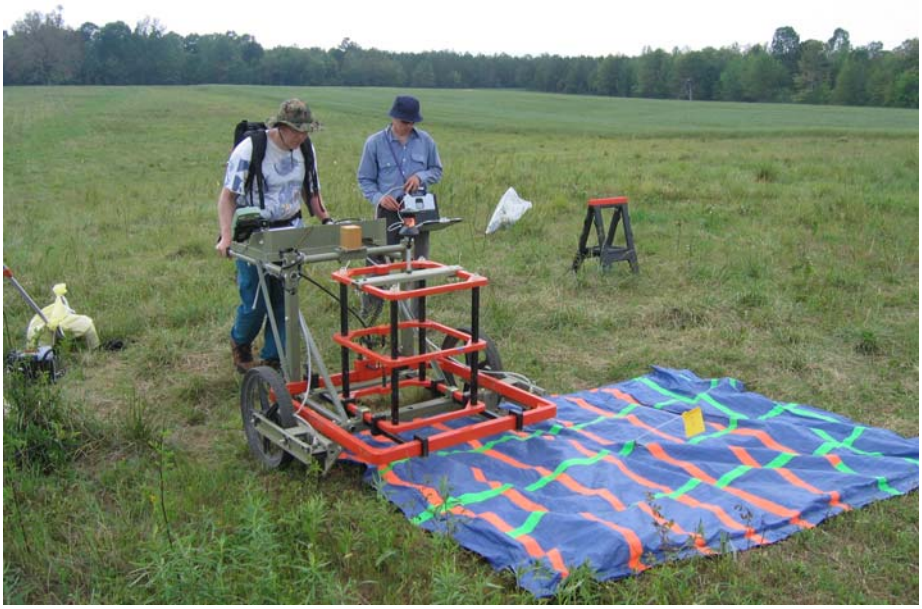

Figure 4. Tarpaulin with marked lanes for cued-interrogation.

2.1.5 Data Processing

A typical processing flow proceeds as follows

- *Initial review of collected data:* Validate that data fall within prescribed recording ranges, establish number of points collected, data density, and time-on / time-off. Reject invalid GPS, IMU or EM-63 readings;
- *Calculation of orientation:* Calculate the orientation of the EM-63 cart using successive GPS/RTS measurements;
- *Data merging:* The EM-63, positioning and orientation data are merged together using the common time-base established by the DAS. The procedure involves interpolation or decimation of each sensor stream to that of the EM-63 (4 Hz).
- *Sensor positioning and orientation:* The 3-D position of the RTS, along with the orientation information from the IMU, are used to accurately calculate the 3-D position and orientation of each geophysical sensor measurement.
- *Background removal:* Approximately every 15-20 minutes, background data are recorded with the EM-63 in a source-free part of the survey area. For each recorded time-gate, a background correction will be applied that is a linear interpolation (as a function of time) between the before and after background measurements.
- *Data gridding:* Filtered data are interpolated onto a 0.1 m grid and reviewed by a geophysicist.

2.2 Previous Testing of the Technologies

The EM-63 sensor system using the Leica RTS as the primary positioning system was used extensively by Sky Research Inc in 2006. Both cued-interrogation and full-detection surveys were collected at the Sky Research Ashland testplot (two weeks) Marine Corps Base Camp Lejeune (four weeks), the Former Lowry Bombing and Gunnery Range (four weeks). Discrimination results derived from full-detection surveys at the Rocket Range and the 20 mm Range Fan at FLBGR are presented in Billings *et al*. (2007a).

2.3 Advantages and Limitations of the Technologies

The main limitations of the EM-63 sensor system relate to the slow rate of survey and the limited range of terrain/vegetation that can be traversed by the cart. Cued-interrogation also introduces additional costs into the DGM process in that each selected anomaly has to be visited with a second geophysical survey system. In addition, the EM-63 only senses the vertical component of the secondary field so that movement of the cart is required to resolve the three components of an object's polarizability. Simulations by Bell (2005) suggest that centimeter level positioning and SNR of 30 dB are required for such systems to accurately resolve the amplitude and relative strength of the polarization components. However, recent results reported at FLBGR reported by Billings *et al*., (2007a) indicate that good discrimination performance can be obtained by the EM-63 with much lower SNR and less positional precision. The time-decay properties of the principal polarization component were sufficient to distinguish 37 mm from 20 mm projectiles, and MK-23 practice bombs from clutter items due to the EM-63's relatively wide measurement range of 180 μs to 25 ms. An advantage of the Sky Research EM-63 sensor system is that all the components (except the cart and DAS) are commercial-off-the-shelf (COTS).

3. DEMONSTRATION DESCRIPTION

3.1 Performance Objectives

Performance objectives for the demonstration are given in Table 2 to provide a basis for evaluating the performance and costs of the demonstrated technology. These objectives are for the technology being demonstrated only; overall project objectives will be given in the demonstration report to be prepared by ESTCP.

Performance metrics of attributes derived from the collected data (e.g. discrimination results) will determine whether this demonstration ultimately meets its desired objective of successful discrimination performance for the EM-63 cued-interrogation system. This discrimination performance will be a consequence of the signal-to-noise ratio, sampling density and orientation/positional integrity of the collected data. To attempt to quantify the effectiveness of the data collection process we have included two metrics of derived attributes. Specifically, the positional and depth accuracy of dipole models recovered from the cued-interrogation data. These will be obtained using inversion procedures documented in the "*Sky Research/University of British Columbia (UBC) ESTCP Discrimination Study, Data Processing Plan*" (Billings *et. al*., 2007b).

Table 2. Performance Objectives/Metrics and Confirmation Methods

Type of Performance Objective	Performance Criteria	Expected Performance (Metric)	Performance Confirmation Method
Qualitative	*Reliability and Robustness*	*General Observations*	*Operator feedback and recording of system downtime (length and cause)*
Quantitative	*Survey Rate*	*20 anomalies / day*	*Calculated from survey results*
	Data Density	*> 40 pts / m^2*	*Calculated from survey results*
	Percentage of Assigned Targets Completed	*100% as allowed by topography / vegetation*	*Calculated from survey results*
	Location accuracy of interpreted anomalies	*< 15 cm*	*Analysis of EM-63 inversion solutions (see Sky/UBC data processing plan)*
	Depth accuracy of interpreted anomalies	*< 10 cm*	*Analysis of EM-63 inversion solutions (see Sky/UBC data processing plan)*

3.2 Pre-Demonstration Testing and Analysis

Prior to mobilization to Camp Sibert, we spent approximately one and a half weeks collecting cued-interrogation data over Sky Research's testplot in Ashland, Oregon. This "shake-down test" allowed the field crew to become more familiar with the operation of the different instruments and in the correct operating procedure for the cued-interrogation surveys. In addition, the survey was used to test the accuracy of feature vectors extracted from the cued-interrogation data (this

analysis will be presented in the demonstration report for the data interpretation phase of the ESTCP Discrimination Pilot Study).

During the Ashland data collection campaign, we also collected static data over a 4.2" mortar at three orientations (horizontal, 45 degree and vertical) at a range of different depths (Figure 5). The depths were measured from the center of the ordnance to the center of the transmitter coil, and then adjusted by 30 cm to account for the height of the coil above the ground. Also shown in Figure 5 is the noise level calculated as the standard deviation of a cued-interrogation survey of an empty cell in the Ashland testplot (and from the GPO at Camp Sibert as per section 4.6).

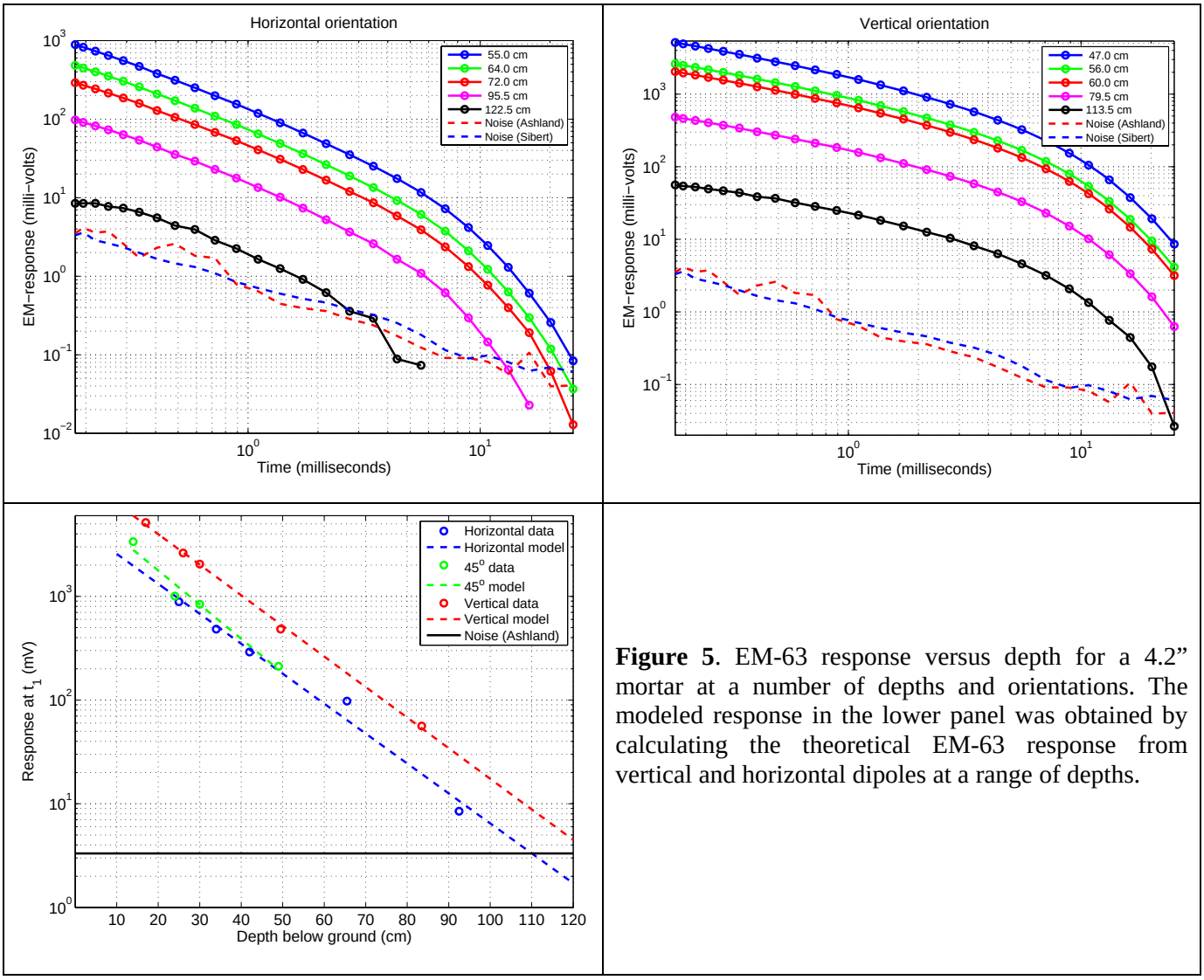

Figure 5. EM-63 response versus depth for a 4.2" mortar at a number of depths and orientations. The modeled response in the lower panel was obtained by calculating the theoretical EM-63 response from vertical and horizontal dipoles at a range of depths.

3.3 Selecting the Test Site

The Camp Sibert ESTCP UXO Discrimination Study Demonstration site is located within the boundaries of Site 18 of the former Camp Sibert FUDS. The land is under private ownership and is used as a hunting camp.

3.4 Test Site History / Characteristics

Information on the Camp Sibert FUDS is available in the archival literature such as an Archives Search Report (ASR) developed in 1993. The former Camp Sibert is located in the Canoe Creek Valley between Chandler Mountain and Red Mountain to the northwest, and Dunaway Mountain and Canoe Creek Mountain to the southeast. Camp Sibert is comprised of mainly sparsely inhabited farmland and woodland and encompasses approximately 37,035 acres. The City of Gadsden is growing towards the former camp boundaries from the north. The Gadsden Municipal Airport occupies the former Army airfield in the northern portion of the site.

The site is located approximately 50 miles northwest of the Birmingham Regional Airport or 86 miles southeast of the Huntsville International Airport. The site is near exit 181 off of Interstate 59 in Gadsden and located approximately 8 miles southwest of the City of Gadsden, near the Gadsden Municipal Airport.

3.4.1 Munitions Use

The area that would become Camp Sibert was selected in the spring of 1942 for use in the development of a Replacement Training Center (RTC) for the Army Chemical Warfare Service. The RTC was moved from Edgewood, Maryland to Alabama in the summer of 1942. In the fall of 1942, the Unit Training Center (UTC) was added as a second command. Units and individual replacements were trained in aspects of both basic military training and in the use of chemical weapons, decontamination procedures, and smoke operations from late 1942 to early 1945. Mustard, phosgene, and possibly other agents were used in the training. This facility provided a previously unavailable opportunity for large scale training with chemical agent. Conventional weapons training was also conducted with several types and calibers fired, with the 4.2-inch mortar being the heavy weapon used most in training.

The US Army also constructed an airfield for the simulation of chemical air attacks against troops. The camp was closed at the end of the war in 1945, and the chemical school transferred to Ft. McClellan, Alabama. The U.S. Army Technical Escort Unit (TEU) undertook several cleanup operations during 1947 and 1948; however, conventional ordnance may still exist in several locations. After decontamination of various ranges and toxic areas in 1948, the land was declared excess and transferred to private and local government ownership. A number of investigations have been conducted on various areas of the former Camp Sibert from 1990 to the present. These investigations included record searches, interviews, surface assessments, geophysical surveys, and intrusive activities.

3.4.2 Demonstration Area Characteristics

The ESTCP UXO Discrimination Study Demonstration Site is located within the confines of Site #18, Japanese Pillbox Area No. 2, of the former Camp Sibert FUDS. Simulated pillbox fortifications were attacked first with WP ammunition in the 4.2-inch chemical mortars followed by troop advance and another volley of high explosive (HE)-filled 4.2-inch mortars. Assault

troops would then attack the pillboxes using machine guns, flamethrowers, and grenades. The locations of nine possible bunkers and one trench in 1943 were identified as part of the 1999 TEC investigation. There is historical evidence of intact 4.2-inch and 4.2-inch mortar debris at the site. As part of the recent investigations, a geophysical survey of Site 18 has been conducted and multiple anomalies were identified. Figure 6 is the Camp Sibert site map with the initial magnetometer survey overlain. After the initial survey, there were three areas selected for use in the discrimination study, South-East-1 (SE1), South-East-2 (SE2) and South-West (SW). The geophysical prove out (GPO) was established immediately adjacent to the SW area.

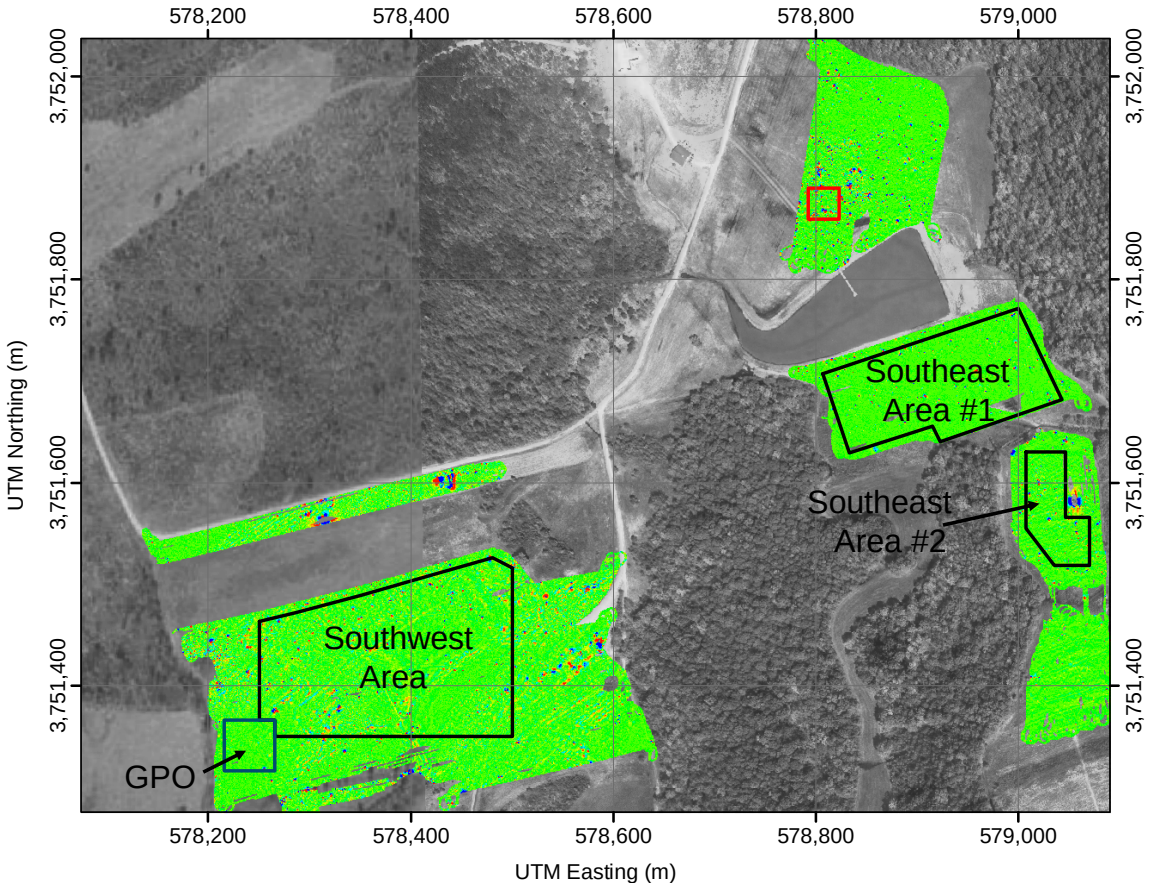

Figure 6. Camp Sibert Site Map with initial magnetometer survey locations shown.

3.4.3 Present Operations

The site is no longer in active use by the military. The demonstration area is owned by a single landowner who uses the area for a hunting camp.

3.5 Testing and Evaluation Plan

3.5.1 Demonstration Set-Up and Start-Up

Sky Research deployed to Gadsden on April 30, 2007 and unpacked and assembled all equipment after receiving a brief tour of the site from Greg Nivens of Parsons. On May 1, a formal site-induction took place and surveying commenced mid-morning. The following general procedures were followed for the survey:

- After collection of the start-of-day calibrations, the sensor operator verified correct operation of all system components prior to commencing data collection.
- For each anomaly, the third crew member set-up the tarpaulin over the flagged location in preparation for the arrival of the EM-63 and its two operators. The anomaly was then surveyed using the procedure outlined in section 2.1.4.
- After every 1-3 anomalies was surveyed, a static background measurement with the EM-63 was conducted at a nearby, source-free location.
- The third-crew member then packed up the tarpaulin and moved it to the next anomaly.

We used two tarpaulins so that the EM-63 was in continual use.

3.5.2 Ground Control

The survey monuments in Table 3 were used for setting up the RTS base-station. Once on site, Sky Research also established a number of control points as listed in Table 4. After deployment it was found that stated position of survey monument 189 was incorrect. This did not affect any data from area SE1 or SE2 as these all RTS set-ups for these sites used points 823 to 825 or additional monuments established by reference to those points.

Table 3. List of primary survey monuments used for the surveying in UTM-Zone 16N, NAD-83.

Survey monuments	Easting (m)	Northing (m)	Elevation (m)
823	578511.244	3751490.302	167.618
824	578472.237	3751508.363	167.452
825	578931.412	3751762.019	158.269
189 (true location)	578487.089	3751490.737	Unknown
189 (assumed location)	578486.975	3751490.960	Unknown
Error in 189	-0.1137	0.2234	

Survey monument 189 was listed in the wrong location and a corrected location was only determined after the surveying.

Table 4. List of monuments established by Sky Research.

Survey monuments	Easting	Northing	Elevation
826 (using incorrect 824 and 189)	578671.501	3571528.055	163.148
826 (using incorrect 189)	578331.204	3751366.579	163.075
826 (using correct 824 and 189)	578332.46	3751364.94	163.075
827 (using incorrect 824 and 189)	578655.082	3571497.965	163.624
827 (using correct 824 and 189)	578325.675	3751398.545	163.624
828	578483.360	3751564.369	165.360
829	578693.131	3751750.378	159.664
830	578777.825	3751875.640	158.791
831	579011.966	3751641.367	157.141
832	578813.347	3751677.857	158.198
834	579040.905	3751549.440	156.746

Those monuments highlighted in yellow were used in their incorrect locations for one or more RTS set-ups.

As monument 189 was the primary monument used by all surveys conducted using GPS, it was decided to use the original assumed set-up location of 189 as the base-line. This meant that all EM-63 data (which were based on correct monument positions) from SE1 and SE2 had to be corrected by subtracting 11.37 cm from the Easting and adding 22.34 cm to the Northing. For data in the south-west area and the GPO there were two complications:

1) Monument 189 was used as a base position or back-site point for some set-ups, including to establish the new control points 826 and 827;

2) The coordinates for monument 824 were entered incorrectly into the RTS and this problem was not discovered until the end of the second day of surveying.

Specific details on the corrections made to the positions for the SW and GPO areas are provided in Appendix B. In Table 5, we list the RTS set-ups used for each day of surveying and identify which anomalies or areas were surveyed using each set-up. As outlined in Section 4.3, the corrections to the positions and orientation of the data were only made after all other processing steps had been completed.

3.5.3 Validation

Initial data processing for each anomaly was performed on-site by a third-member of the survey team. This processing was done to verify the integrity of the data collected and enabled any data problems to be immediately found and rectified. Initially, this third member was the project principal investigator (PI) who remained on-site for the first week. During the second week, the

Data Acquisition Operator took over responsibility for the initial data processing; at that point a second field-technician was mobilized to the site to assist with the data collection.

Table 5. List of RTS set-up locations.

Date	Base	Back-site	Data Collected
May 1, 2007 (d07121)	824	189	Shot in control point 826. Note: Both 824 and 189 were in error
May 1, 2007 (d07121)	826	824	SW: cued-interrogation over 6 items Note: Both 824 and 826 were in error
May 2, 2007 (d07122)	827	826/824 (resection)	SW: cued-interrogation over 22 items Note: Both 824 and 826 were in error
May 3, 2007 (d07123)	824	823	SW: cued-interrogation data over 36 items
May 4, 2007 (d07124)	825	830	SE1: cued-interrogation over 31 items, shot in 2 new control points (831, 832) for future work on SE grids
May 5, 2007 (d07125)	831	825	SE1: cued-interrogation over 27 items
May 6, 2007 (d07126)	832	825	SE1: cued-interrogation over 11 items
May 6, 2007 (d07126)	831	825	SE2: cued-interrogation over 35 items
May 7, 2007 (d07127)	831	832	SE2: Shot in new location (834) for obscured target, cued-interrogation over 30 items
May 7, 2007 (d07127)	834	830	SE2: cued-interrogation over 1 obscured (shed) target
May 7, 2007 (d07127)	832	831	SE1: recollect of obscured (trees) target
May 8, 2007 (d07128)	189	823	SW: Re-establish corrected 826 (called S826)
May 8, 2007 (d07128)	826	189	SW: Cued surveying of 38 items in GPO and 3 remaining SW items Note: Both 826 and 189 were in error
May 9, 2007 (d07129)	834	831	SE2: recollects of 11 items
May 9, 2007 (d07129)	832	831	SE1: recollect of 1 item
May 10, 2007 (d07130)	832	825	SE1: Series of 4 line transects on
May 10, 2007 (d07130)	826	189	SW: Full coverage of GPO @ 0.5m line spacing Note: Both 826 and 189 were in error
May 11, 2007 (d07131)	826	189	SW: 2 GPO cued-interrogation recollects, 100'x100' full coverage east of GPO Note: Both 826 and 189 were in error

Those shown in yellow involved incorrect positions of one or more of the monument positions and required correction as outlined in Appendix B.

3.5.4 Period of Operation

The demonstration commenced on May 1, 2005 and was completed on May 11, 2007. A summary of activities on each day are provided in the table below, with a more detailed description provided in Appendix C.

Table 6. Summary of on-site activities.

Day	Summary of activities
April 30, 2007	Pickup equipment from FedEX, assemble survey cart, charge batteries and acquire supplies.
May 1, 2007	Site overview, established survey control and collected cued-interrogation data over 7 marked items in the SW area.
May 2, 2007	Collected cued data over 23 items in the SW area.
May 3, 2007	Collected cued data over 36 items in the SW area. Established 3 additional control points for surveys in the SE1, SE2 areas.
May 4, 2007	Collected cued data over 31 items in the SE1 area. Established 2 additional control points for surveys in the SE1, SE2 areas.
May 5, 2007	Collected cued data over 27 items in the SE1 area.
May 6, 2007	Collected cued data over 11 items in the SE1 area, 35 items in the SE2 area.
May 7, 2007	Collected cued data over 31 items in the SE2 area, recollect 1 item in the SE1 area.
May 8, 2007	Collected cued data over 38 items in the GPO, 3 remaining items in the SW area.
May 9, 2007	Recollected cued data over 11 items in SE2 and 1 item in SE1. Collected one 4 line transect of full extent of SE1.
May 10, 2007	Completed series of 4 line transects over full extent of SE1. Full coverage of GPO at 0.5m line spacing.
May 11, 2007	Recollected cued data over 2 anomalies in GPO. Continued full coverage at 0.5 m line spacing for another 100ft east of the GPO. Disassemble and pack survey equipment for shipping.

3.5.5 Scope of Demonstration

Cued-interrogation data were collected at the Camp Sibert ESTCP UXO Discrimination Demonstration Site, approximately 8 miles southwest of the City of Gadsden, AL. The location of 38 items in the GPO and 200 anomalies to survey were provided by the ESTCP Program office. The items in the various areas were distributed as follows:

1) 68 anomalies in SE1 (anomalies SE1-1 to SE1-68);
2) 64 anomalies in SE2 (anomalies SE2-1 to SE2-64);
3) 68 anomalies in SW (anomalies SW-1 to SW-68); and
4) 38 anomalies in the GPO (anomalies GPO-1 to GPO-38).

A 3 m by 3 m section of data was collected around each anomaly using the cued-interrogation process described in Section 2.1.4. In addition to the cued-interrogation surveys, the following full-coverage surveys were conducted over:

1) The GPO; and
2) A 35 m by 60 m section in the SW area;

The located EM-63 data of each cued-interrogation anomaly and the full coverage surveys were provided to the Program Office in early June 2007.

3.5.6 Demobilization

At the end of field operations, all equipment, materials, and supplies were removed from the site and returned to Sky Research's head office in Ashland, Oregon.

3.5.7 Health and Safety Plan

A host organization exists for this demonstration site. All field work was conducted under the authority of the existing work plan. An abbreviated accident prevention plan was prepared and submitted prior to the deployment as requested by the U.S. Army Corps of Engineers (USACE). No separate Health and Safety Plan was required.

3.6 Management and Staffing

The responsibilities for this demonstration are outlined in Figure 7. Dr. Stephen Billings is the PI for this project and also filled the role of Quality Assurance Officer. Mr. Kevin Kingdon was the Data Acquisition Operator. His duties included data collection, safety oversight, and supervision of the supporting field technicians. Dr. Billings also was the Data Analyst for this effort.

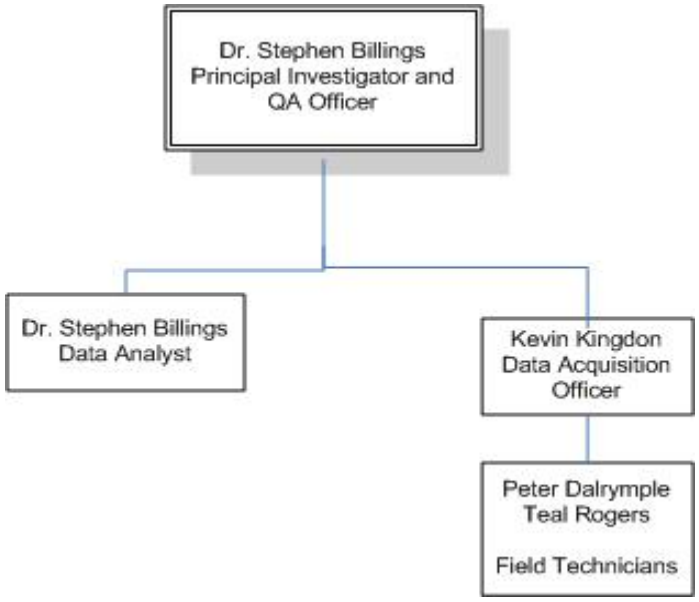

Figure 7. Management and Staffing Wiring Diagram

4. CALIBRATIONS, DATA PROCESSING AND ARCHIVING

4.1 Initial Quality Control

Each night an initial QC of the data was conducted by the QA officer to determine if there were any problems with the data that would require any anomalies to be recollected. A detailed list of the QC results is provided in Appendix D and a brief summary is presented in Table 7 below.

Table 7. Summary of QC issues by day.

Day	QC summary
May 1, 2007	Incorrect RTS set-up which will require positions and orientations to be corrected.
May 2, 2007	Incorrect RTS set-up which will require positions and orientations to be corrected
May 3, 2007	No significant QC issues.
May 4, 2007	No significant QC issues.
May 5, 2007	No significant QC issues.
May 6, 2007	Need to recollect SE1-12 due to missing RTS data and SE2-10 due to drifting IMU
May 7, 2007	DAS issue that caused a loss of data from 12 anomalies in SE2.
May 8, 2007	Need to recollect GPO-2 due to drifting IMU data and GPO-24 due to missing RTS data
May 9, 2007	No significant QC issues.
May 10, 2007	No significant QC issues.
May 11, 2007	No significant QC issues.

4.2 Daily calibrations

A summary of the daily calibration results is provided in Table 8. Figures 8 and 9 plot the amplitudes of the daily static-spike-static and calibration line tests. Ideally, these two calibrations would have been calculated at the start and end of each day, but due to the EM-63 logger battery issue, the end of day calibration was not always possible.

Table 9 and Figure 10 summarize the results of the daily “four-corners test” which is designed to estimate the location of the RTS prism relative to the transmitter coil. The results indicate that the RTS prism is 0.3 cm to the right and 0.25 cm behind and 72 cm above the center of the transmitter. These numbers are used to merge the positions of the RTS prism with the sensor data from the EM-63 and the orientation data from the IMU.

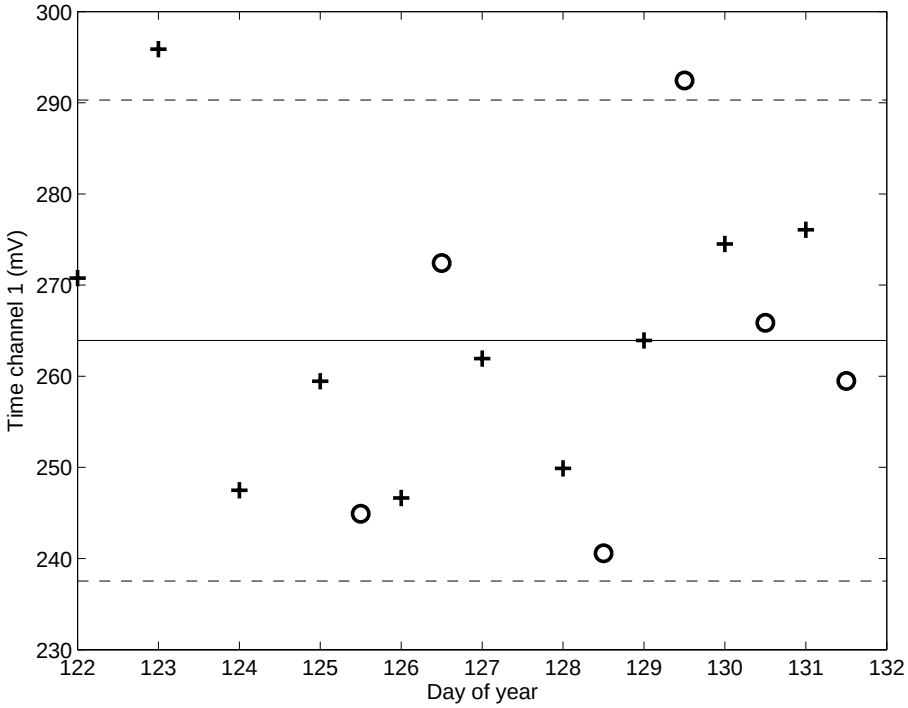

Figure 8. Daily calibrations with a metal-loop and the EM-63 elevated on a saw-horse. The median of the calibrations is shown as a solid black line, with +- 10% of the median shown as dashed lines. All except two calibrations are within 10% of the median value.

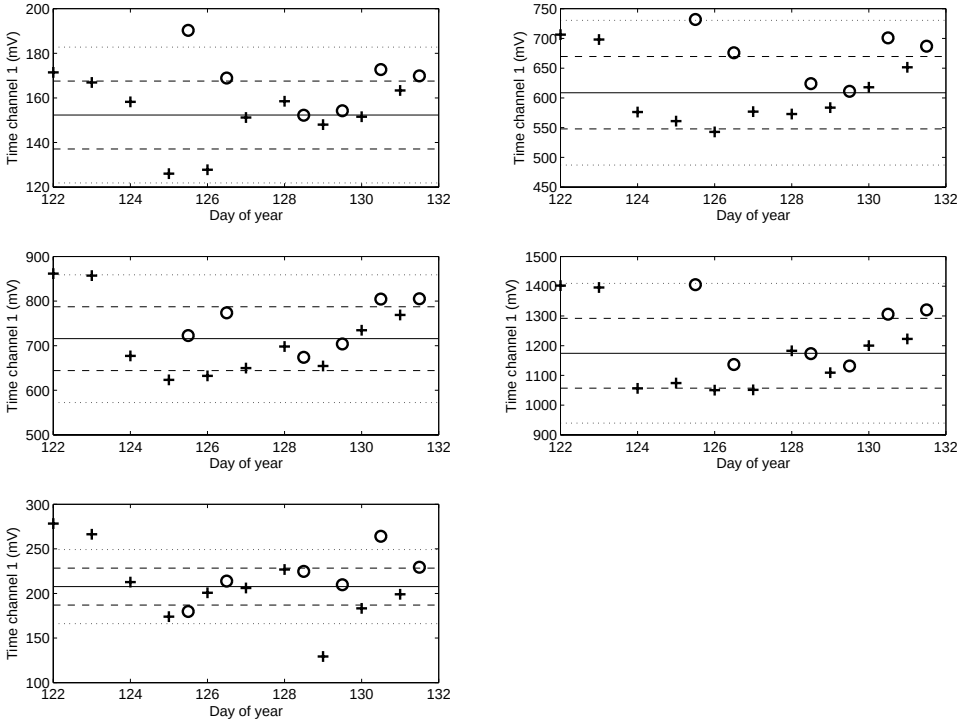

Figure 9. Daily calibrations along the calibration line. The mean of the calibrations is shown as a solid black line, with +- 10% of the mean shown as dashed lines and +-20% as dotted lines.

Table 8. Compilation of daily calibrations results including the sensor and IMU slew-rates relative to the RTS.

Day	Sensor Slew (sec)	IMU slew (sec)	Prism Height (cm)	Roll corr. (deg)	Pitch corr. (deg)	EM-63 Height (cm)	t1 static (mV)	t1 spike (mV)	t1 static (mV)	Spike minus static (mV)	Anom 1 minus back (mV)	Anom 2 minus back (mV)	Anom 3 minus back (mV)	Anom 4 minus back (mV)	Anom 5 minus-back (mV)
May 1	-0.037	0.31	71.8	-1.2	-0.3	29.8	-6.5	430.0	-8.3	437.5	181.1	663.8	814.5	1303.9	212.1
May 2	-0.095	0.58					-1.5	269.8	-0.4	270.8	171.5	706.4	861.6	1402.0	278.4
May 3	-0.042	0.34	71.8	-0.19	-0.62	27.9	21.9	316.3	19.0	295.9	166.7	698.0	856.9	1395.4	266.2
May 4		0.31	71.8	-0.27	-0.54	31.8	-11.4	235.0	-13.7	247.5	158.3	576.2	677.0	1056.3	212.8
May 5 am		0.3	72	-0.13	-0.36	30.5	-7.9	250.3	-10.4	259.4	125.6	560.6	622.9	1073.7	173.6
May 5 pm							-35.6	207.9	-38.4	244.9	173.7	715.3	706.2	1388.6	163.3
May 6 am	-0.04	0.29	71.9	-0.54	-0.74	30.5	1.1	249.4	4.5	246.6	127.9	542.9	632.3	1050.4	200.9
May 6 pm							-2.0	269.7	-3.4	272.4	168.0	675.2	772.6	1135.7	212.9
May 7	-0.051	0.31	72	0.14	-0.95	30.5	1.3	262.3	-0.5	261.9	151.2	576.9	649.7	1051.5	206.1
May 8 am	-0.002	0.32	72.3	-0.55	-0.73		-126	123.8	-126	249.9	148.4	562.8	688.2	1172.8	216.7
May 8 pm							-5.0	234.5	-7.2	240.6	151.2	622.9	673.0	1172.2	223.6
May 9 am			72.1	-0.52	-0.44	31.1	-0.9	261.8	-3.2	263.9	148.0	583.6	654.4	1109.3	129.3
May 9 pm							-3.3	289.1	-3.4	292.5	154.0	610.9	703.7	1131.4	209.5
May 10 am			71.8	-0.34	-0.33	30.5	-3.2	271.1	-3.6	274.5	151.6	617.9	734.7	1200.2	183.3
May 10 pm							-0.8	262.9	-5.2	265.9	171.4	699.7	803.2	1304.7	262.9
May 11 am			72.2	-0.42	-0.54		-4.6	270.3	-7.0	276.1	163.2	651.3	768.7	1222.4	199.0
May 11 pm							9.9	268.8	8.7	259.5	171.3	688.3	806.6	1321.9	230.7

These tests were incorrectly executed after the morning of May 8 and no calibration results could be obtained. Also included are the results of the four-corners test showing the predicted location of the prism and the expected roll and pitch correction for the IMU, and the coil height measurement done every one to two days. The value of the response at time-channel 1 during the static-spike-static and calibration lane tests (anomalies 1 to 5) are also shown. The column "Spike minus static" contains the spike measurement minus the average of the static measurements. The calibration anomalies are listed as "Anom N minus back" for N=1 to 5, with the background calculated over a location with no metallic anomaly. The static-spike-static test on the first day used a smaller distance between the transmitter and calibration coil which explains the larger value shown.

Table 9. Measured offsets of the coil center relative to the RTS prism.

Day	Sideways offset (cm)	Forward offset (cm)	Vertical offset (cm)	Used
121	-1.46	1.26	-71.76	No
123	0.41	0.08	-71.84	Yes
124	-0.22	0.21	-71.8	Yes
125	-0.55	0.5	-72.01	Yes
126	0.14	0.42	-71.86	Yes
127	0.24	2.01	-72.03	No
128	-0.35	0.34	-72.31	Yes
129	1.46	-0.1	-72.11	No
130	-0.73	0.37	-71.81	Yes
131	-0.83	-0.17	-72.22	Yes
Average	-0.3043	0.25	71.98	

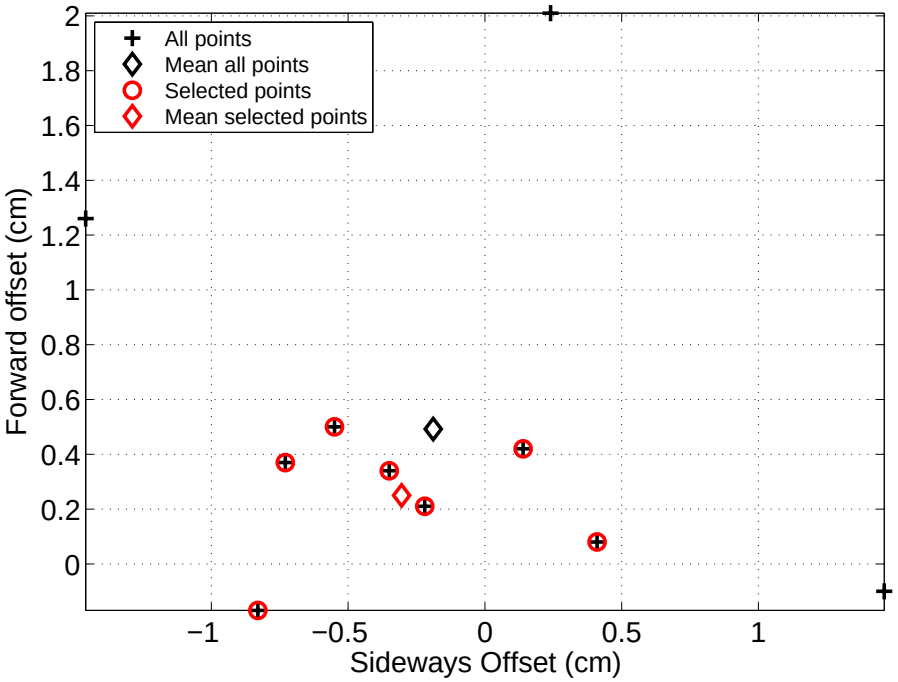

Figure 10. Results of all RTS four-corners tests showing the predicted location of the center of the coil relative to the RTS prism. The mean location from the red points puts the center of the coil at 0.3 cm to the left and 0.25 cm in front of the prism. The results from the black + signs were not used in calculating the coil location.

4.3 Data Processing

After initial QC and removal of obvious erroneous data, each cued-interrogation data-set was subjected to the same processing sequence as follows:

- ***Removal of spikes in EM-63 data***: Invalid EM-63 measurements (marked by a special character during logging) and any spikes in the bottom or top-coil measurements were deleted;
- ***Current normalization:*** The raw-output of the EM-63 was normalized to a nominal transmitter current of 15 Amperes (A) by multiplying each channel by *current/15* (where current is the transmitter current output by the EM-63);
- ***Background correction of EM-63 data:*** For each time channel a linearly interpolated background value was removed. For example, assume that the background in the specified time-channel is B_1 at time t_1 and B_2 and time t_2, then the background $B(t)$ at a time t with $t_1 < t < t_2$, is obtained as:

  $$B(t) = B_1 + (B_2 - B_1)\,(t - t_1) / (t_2 - t_1)$$

  If there was no background measurement proceeding or subsequent to the survey, then the background is assumed to be constant (at either B_1 or B_2 depending on whether the measurement is before or after the survey).
- ***Correction of sensor and IMU time****:* The DAS recorded times of the sensor and IMU were adjusted to agree with the time-base of the RTS using the following values:
  - ***Sensor****:* Times were adjusted by 0.04 seconds;
  - ***IMU****:* Times were adjusted by +0.31 seconds;
- ***Data merging****:* The EM-63, RTS and IMU data were merged together using time as a reference. The procedure involves interpolation or decimation of the RTS and IMU stream to that of the EM-63 (4 Hz).
- ***Calculation of orientation (survey lines)****:* The azimuth of the EM-63 cart was calculated using successive RTS measurements augmented by the IMU data in an iterative procedure as follows:
  1) The RTS data were first smoothed using a 7 point moving average and any points closer together than 0.1 m were rejected (this smoothing is only done to compute the azimuth and is not propagated to the final, reported positions);
  2) The azimuth of the coil is estimated through adjacent RTS measurements assuming the direction of travel is the same as the coil azimuth;
  3) The pitch and roll from the IMU are used to estimate the position of the center of the transmitter coil assuming the RTS prism is located 0.72 m above the coil center.

4) The azimuth of the coil is recalculated using the transmitter coil location estimated from 3);

5) Steps 3) and 4) are repeated one more time to obtain the final estimated azimuth.

This procedure is used to prevent distortions in the sensor azimuth that arise due to pitch and roll of the RTS prism.

- ***Calculation of orientation (pitch lines)****:* The azimuth of the EM-63 cart was calculated using the first and last point in the pitch line.
- ***Sensor positioning and orientation****:* The 3-D position of the RTS, along with the orientation information from the IMU, are used to accurately calculate the 3-D position and orientation of the center of the EM-63 transmitter coil using the known geometry of the cart. For this geometric correction we assumed the center of the transmitter coil relative to the prism was.
  - 0.003 m to the left (facing forwards);
  - 0.0025 m in front; and
  - 0.72 m below
- ***Corrections to positions and orientation due to survey monument issues****:* Due to the survey monument issues described in section 3.5.2, the positions and/or azimuths of the data had to be adjusted to coincide with the shifted coordinate system used for this demonstration. The specific corrections applied to each set of data are listed in Table 10 below.

Table 10. List of geographic corrections made to the data to account for incorrect monument locations.

	Pre-rotation translation		Rotation	Post-rotation translation			
Dataset	**Easting (m)**	**Northing (m)**	**clockwise**	**Easting**	**Northing**	**Anomalies**	**Comments**
SE1 and SE2	-0.1137	0.2234	0	0	0	All	Correct locations used in set-up. Adjustment made to agree with incorrect location of 189
SW, GPO Cued SW, GPO Full	-578331.204	-3751366.579	-0.52125	578332.342	3751365.167	SW-1, -8 and -61. All GPO and full coverage data	Error in 189 and in 826 (backsite set-up)
SW cued	-578671.501	-3571528.055	139.9081	578332.456	3751364.944	4, 7, 9, 13, 17, 22	Error in 189 and in 824 (backsite set-up)
SW cued	-578655.082	-3571497.965	139.9011	578325.561	3751398.768	15, 16, 20, 23, 24, 25, 28, 32, 33, 34, 35, 36, 37, 39, 40, 41, 47, 48, 53, 57, 58, 60, 64	Error in 189 and in 824 (resection set-up)

4.4 Data Archiving

The cued-interrogation and full-coverage data were archived as Geosoft XYZ files with the following information:

- Easting and Northing of the center of the transmitter coil (in meters, Universal Transverse Mercator [UTM] Zone 16, North American Datum [NAD]-83), with the coordinate system translated by 0.1137 m East and -0.2234 m to coincide with the demonstration's shifted coordinate system;
- Elevation of the center of the transmitter coil (in meters above ellipsoid);
- t1 to t26 which comprise the bottom-coil minus top-coil response (in millivolts) of the EM-63 at the following 26 geometrically spaced time-gates: 0.180, 0.195, 0.220, 0.250, 0.290, 0.340, 0.405, 0.485, 0.590, 0.720, 0.890, 1.105, 1.375, 1.725, 2.170, 2.740, 3.465, 4.385, 5.565, 7.070, 8.905, 10.780, 13.220, 16.280, 20.150 and 25.140 milliseconds. The data were normalized to a 15 A transmitter current and were background corrected as described in section 4.3;
- Top-coil which comprises the middle-coil minus top-coil response (in millivolts) in an EM-61 equivalent time-gate which is calculated as

  $$V_t = (0.782\ t_8 + t_9 + 1.264\ t_{10} + 1.621\ t_{11}) / 4.6667$$

  where t_n is the response in the n-th time-gate identified in the previous paragraph. The data were normalized to a 15 A transmitter current and were background corrected as described in section 4.3.
- Roll, pitch and azimuth are Euler rotation angles that represent the orientation of the coil in degrees. See Figure 11 for a definition of the coordinate system and the rotation conventions. To rotate from the coordinate system of the coil to the Earth frame of reference, we roll first, then pitch, then rotate using the azimuth.
- Current is the transmitter current in the EM-63 coil (in Amperes);
- Time is the DAS time-stamp of the EM-63 sounding adjusted to correspond with the time-base of the RTS (in seconds past an arbitrary start point).

Note that none of the data have been filtered so that there may be small temporal or spatial offsets in the EM-63 data. The GPO cued-interrogation data are labeled as per the ID column in Table 11

4.5 Data QC summary

Appendix E identifies the survey events that were collected for each anomaly and also includes any QC comments or observations. The only significant QC problem that we found post-survey concerns the IMU data of anomaly SE2-18. The pitch and roll values returned from the IMU were drifting appreciably and are probably not valid. There were

3 anomalies with part of a line, or an entire line missing (SW-23, SW-34, SW-58) and 2 anomalies with missing or poor pitch lines (SW-12 and SW-60).

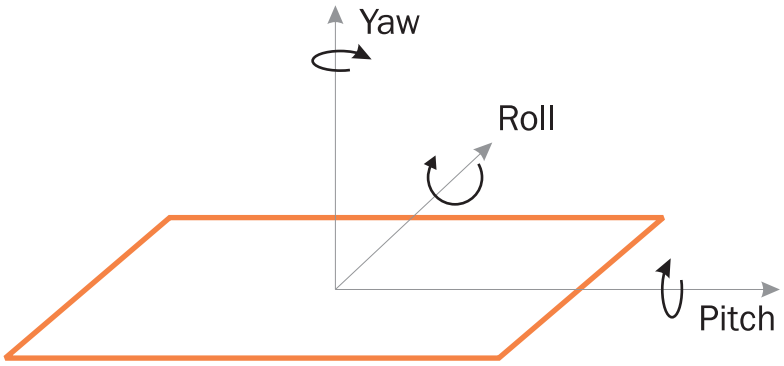

Figure 11. Definition of Euler angles used to determine the orientation of the EM-63 coil. Yaw is used equivalently to azimuth for this system as we assume the EM-63 is orientated parallel to the direction of travel.

4.6 Geophysical Proveout

Table 11 lists the location, depth, azimuth and dip of each of the items in the Geophysical Prove Out along with the maximum amplitudes (excluding pitch-lines) observed during the cued and full coverage surveys. In Figure 12 we plot the maximum response at time-channel 1 of the EM-63 against the ground-truth depth for each of the intact and partial 4.2” mortars. The amplitudes of the intact rounds generally fall between the horizontal and vertical measurements taken in Ashland, although there are a number of items with larger response that expected. In addition, the cued-interrogation data generally have larger amplitude than the full-coverage data due to a higher density of data points (more likely to sample a point near the true anomaly maximum. Also shown on the plot is the estimated noise floor on the GPO (3.3 mV) calculated as the standard deviation of an object free section of full-coverage data.

Figures 13 and 14 show raw and demedian filtered full-coverage data over the GPO from time-channel 1. From the raw data it is apparent that there is an increase in the soil background in the Northern part of the GPO.

Table 11. Items emplaced in the GPO.

STRINGID	ID	UTMEAST	UTMNORTH	DEPTH	INCLINATION	AZIMUTH	t1 100% coverage (mV)	t1 Cued (mV)
42-002	1	578217.01	3751318.19	0.14	11	9	1240.8	2070.2
42-012	2	578224.81	3751345.95	0.4	-6	215	360.9	362.4
42-016	3	578217.44	3751357.81	1.06	90	0	11.1	15.7
42-041	4	578222.98	3751323.69	0.2	8	78	1577.5	2536.0
42-046	5	578254.41	3751331.84	0.37	-90	0	1425.1	1992.7
42-052	6	578260.56	3751353.38	0.47	-90	0	415.9	1036.6
42-055	7	578237.27	3751341	0.47	44	55	181.5	306.8
42-060	8	578245.07	3751341.22	0.5	7	143	205.4	192.2
42-061	9	578227.16	3751337.24	0.38	-51	76	477.2	1204.4
42-064	10	578259.76	3751365.32	1.1	-5	266	6.9	11.5
42-065	11	578251.82	3751350.88	0.72	-50	61	175.3	89.3
42-067	12	578234.47	3751347.35	0.4	90	0	641.7	622.2
42-070	13	578229.01	3751353.93	1.11	42	196	4.6	14.7
42-079	14	578247.82	3751364.79	1.18	1	77	7.6	10.7
42-080	15	578238.12	3751361.27	0.76	33	210	85.6	109.4
42-085	16	578263.14	3751329.38	0.29	90	0	1531.9	1225.7
42-100	17	578220.61	3751364.8	1.07	-90	0	36.0	33.4
42-103	18	578218.09	3751336.77	0.32	-51	164	582.5	1207.2
42-134	19	578216.69	3751347.31	0.4	7	127	373.4	406.7
42-142	20	578252.26	3751321.62	0.15	0	286	2607.8	3436.4
42-145	21	578228.44	3751361.6	0.67	90	0	99.3	129.9
42-149	22	578260.88	3751317.68	0.37	90	0	797.4	1272.1
42-150	23	578239.55	3751319.4	0.18	-5	222	2418.4	3899.2
42-153	24	578246.65	3751327.64	0.36	-90	0	1318.7	2953.1
42-158	25	578244.94	3751355.46	0.71	2	137	57.8	57.3
42-160	26	578240.62	3751335	0.39	35	82	481.6	660.1
42-171	27	578229.33	3751318.27	0.13	2	138	2371.4	3935.9
42-172	28	578264.47	3751341.49	0.43	-90	0	836.5	801.8
42-178	29	578232.93	3751329.85	0.38	42	182	316.0	1048.2
42-179	30	578250.43	3751342.6	0.47	-51	212	361.5	335.0
HR-1	31	578221.97	3751352.41	0.12	flat	0	326.0	1048.4
HR-2	32	578235.35	3751355.46	0.13	flat	0	1071.3	1471.2
HR-3	33	578242.56	3751347.25	0.11	flat	0	880.7	1126.2
HR-4	34	578253.78	3751359.98	0.13	on edge	0	869.9	1254.9
HR-5	35	578257.34	3751345.56	0.1	on edge	0	827.6	956.6
HR-6	36	578258.66	3751337.02	0.16	on edge	0	744.3	915.4
HR-7	37	578249.01	3751336.22	0.35	flat	0	262.8	291.6
HR-8	38	578217.04	3751330.51	0.43	on edge	0	85.0	150.6

The first 30 items are intact 4.2” mortars, the last 8 are partial rounds. Depth is in meters relative to the center of the object, inclination in degrees from horizontal and azimuth in degrees relative to UTM-North (measured clockwise to direction of nose. Also shown are the maximum amplitudes in time-channel 1 of the full-coverage and cued-interrogation surveys in a 1.25 m region around each ground-truth location.

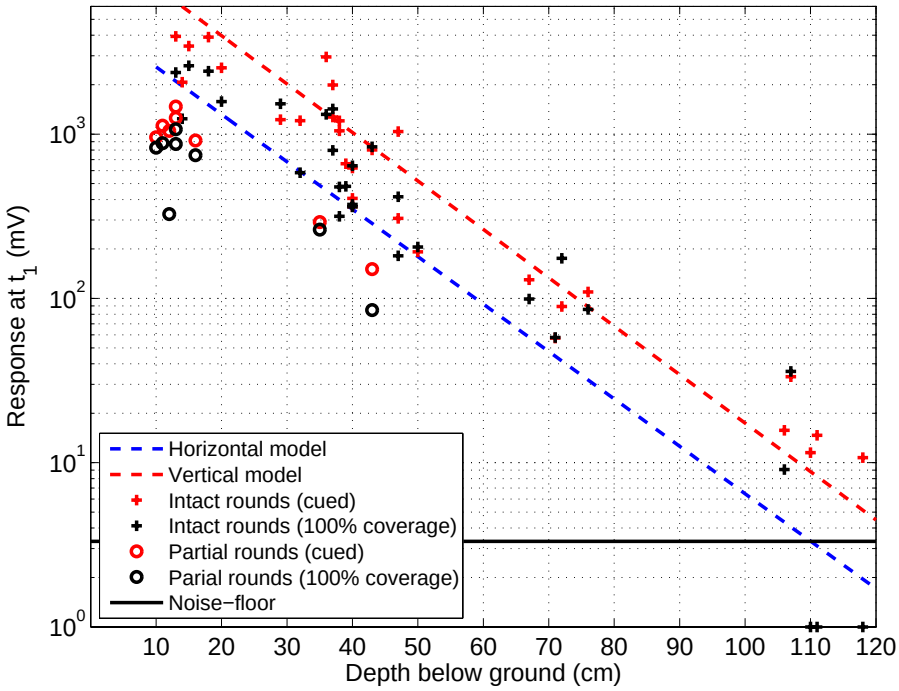

Figure 12. Maximum amplitude at time-channel 1 versus depth of burial for intact and partial 4.2" rounds in the GPO for both the full-coverage and cued surveys.

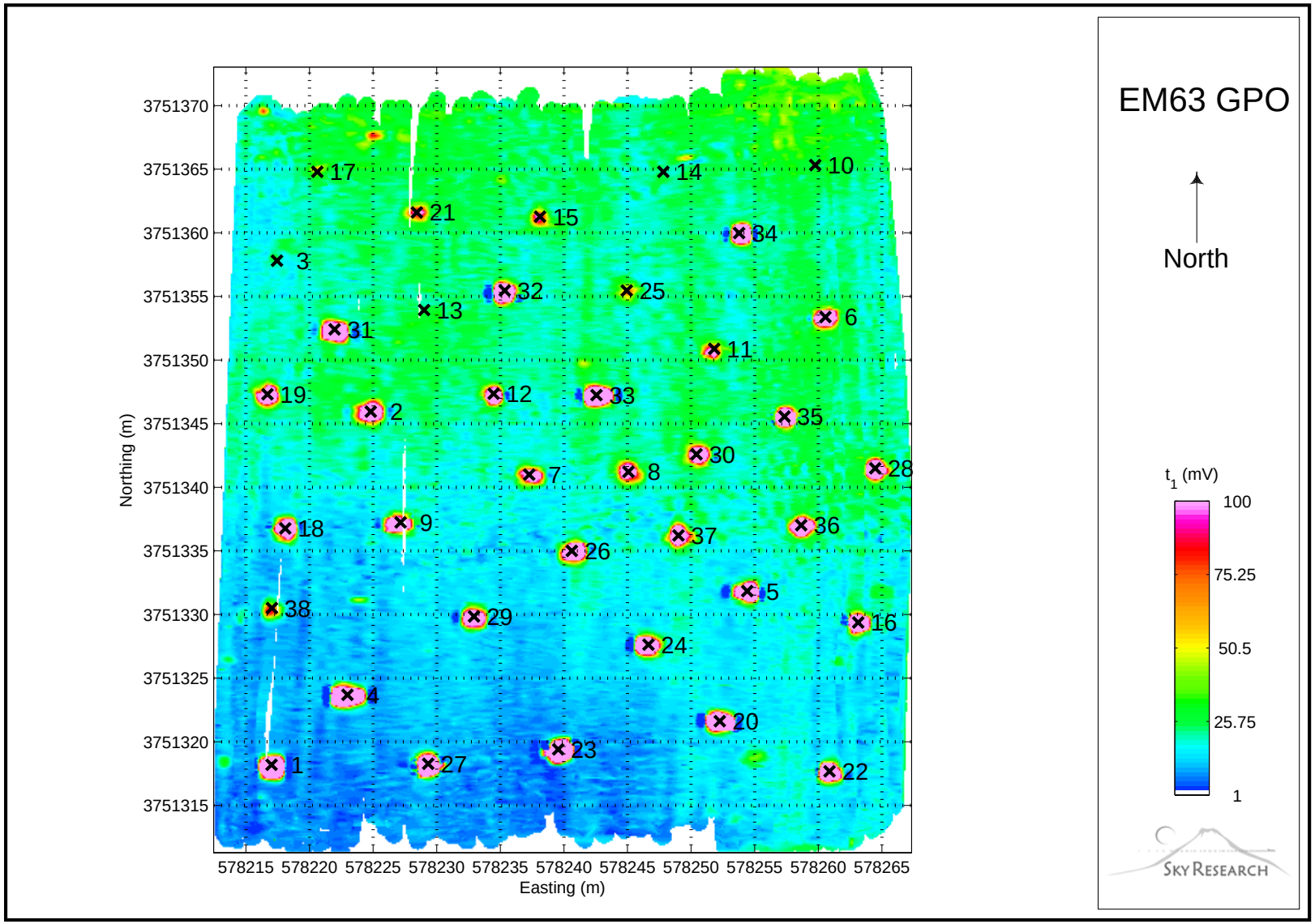

Figure 13. Image of time-channel 1 of the full-coverage EM-63 data on the GPO

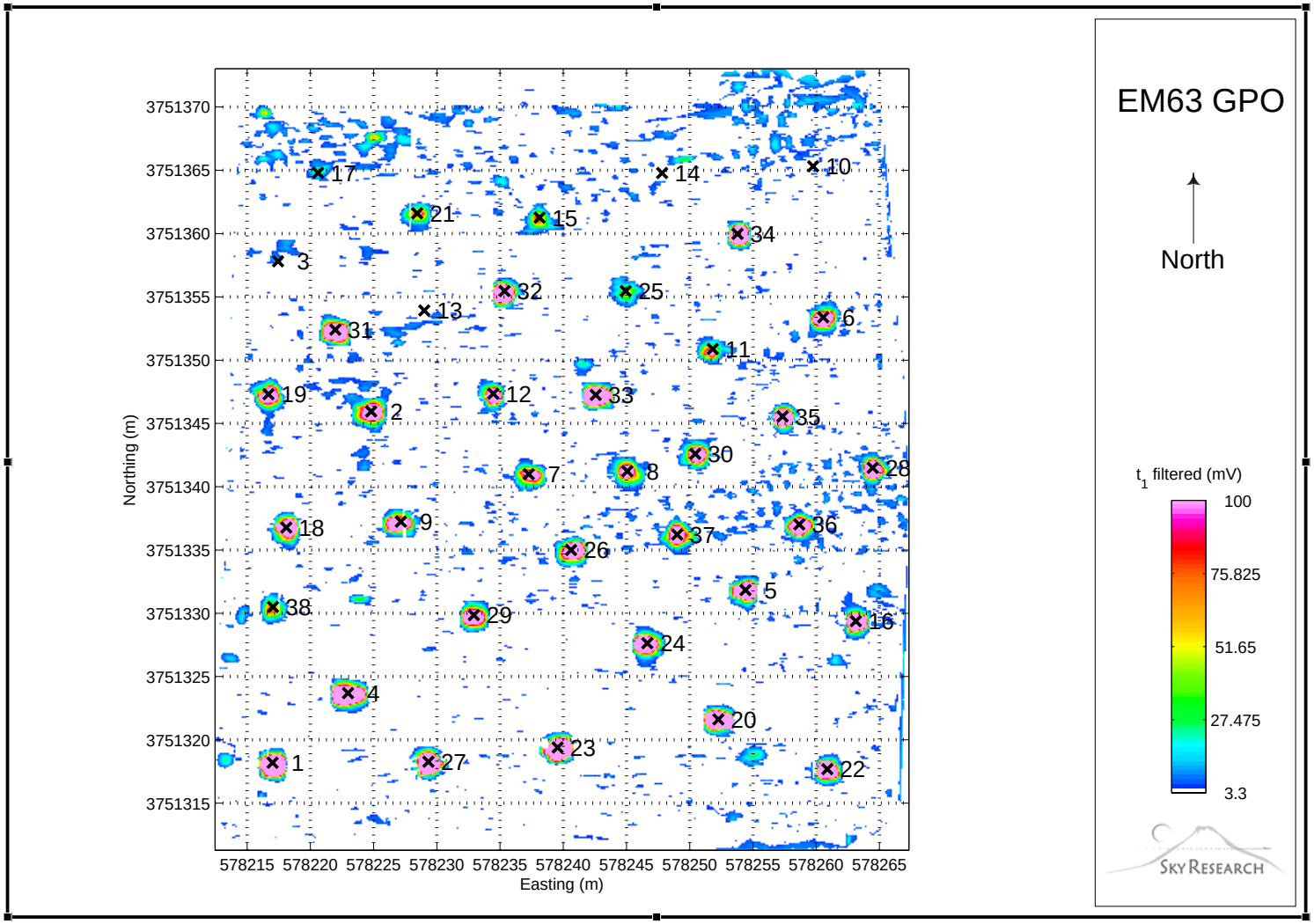

Figure 14. Image of time-channel 1 of the full-coverage EM-63 data on the GPO after application of a demedian filter. Grid-cells with amplitude below the standard deviation of the noise are shown in white

5. PERFORMANCE ASSESSMENT

5.1 Performance Criteria

Table 2 listed the performance criteria for the demonstration. We now list each of the other performance objectives and determine if they have been met.

5.1.1 Reliability and Robustness

Objective: General observations.

Performance: Met.

As indicated in section 4, the data collection proceeded with few technical problems and the EM-63 was found to be reliable and robust. The main issues encountered were (1) the poor charge holding capacity of the EM-63 logger battery; and (2) a crash of the DAS that resulted in the recollection of 12 anomalies. The first issue was resolved by purchasing a new logger battery, while the second issue was something that we have rarely encountered with the DAS (it is used extensively in some of our other sensors systems including the Helimag system).

The main issue that needed to be resolved post-survey concerned the RTS set-ups in the South-West and GPO sections of the site. This was more difficult than for those systems that utilized GPS due to the corrections requiring both translation and rotation. With careful planning and survey control, these set-up problems can be avoided, so we don't believe this is a significant issue with RTS technology.

5.1.2 Survey Rate

Objective: 20 anomalies / day.

Performance: Met.

Figure 15 plots the number of anomalies that were surveyed each day. Apart from the first day, when we didn't start surveying until almost lunch-time, we always surveyed at least 20 items per-day. Neglecting the first day, the average survey rate was 33.6 items. Note that until 6 May, we could not survey for a full day as the EM-63 logger battery would not hold its charge for more that about 4-5 hours. After that date, there were two days where we surveyed over 40 items, which is a realistic productivity target.

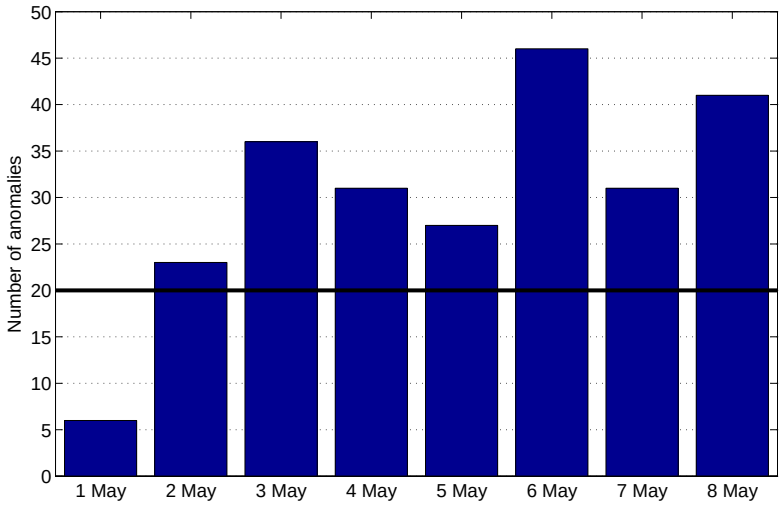

Figure 15. Number of cued-interrogation anomalies surveyed each day.

5.1.3 Data Density

Objective: Greater than 40 pts / m^2

Performance: Met.

This performance metric was calculated by analyzing 6 anomalies picked at random with 2 each from the SE1, SE2 and SW areas (Table 12). A polygon encompassing the area covered by the survey was then manually defined around each anomaly (Figure 16). The area of this polygon and the number of EM-63 soundings within the polygon (minus any data on the pitch lines) were then calculated, which allowed the anomaly density to be estimated. The average anomaly density calculated by this method was 66.6 points per m^2, which is well above the 40 points per m^2 used as the performance metric.

Table 12. Data densities computed for 6 randomly selected anomalies.

Anomaly	Number points	Area (m^2)	Density (# per m^2)
SW-13	817	12.8	63.8
SW-65	574	8.74	65.6
SE1-16	694	10.9	63.8
SE1-41	586	8.1	72.8
SE2-33	716	9.9	72.4
SE2-61	625	10.2	61.4
Average	**669**	**10.1**	**66.6**

5.1.4 Percentage of Assigned Targets Completed

Objective: 100% as allowed by topography / vegetation.

Performance: Met.

Review of the collected data reveals that 100% of all cued-interrogation anomalies were surveyed.

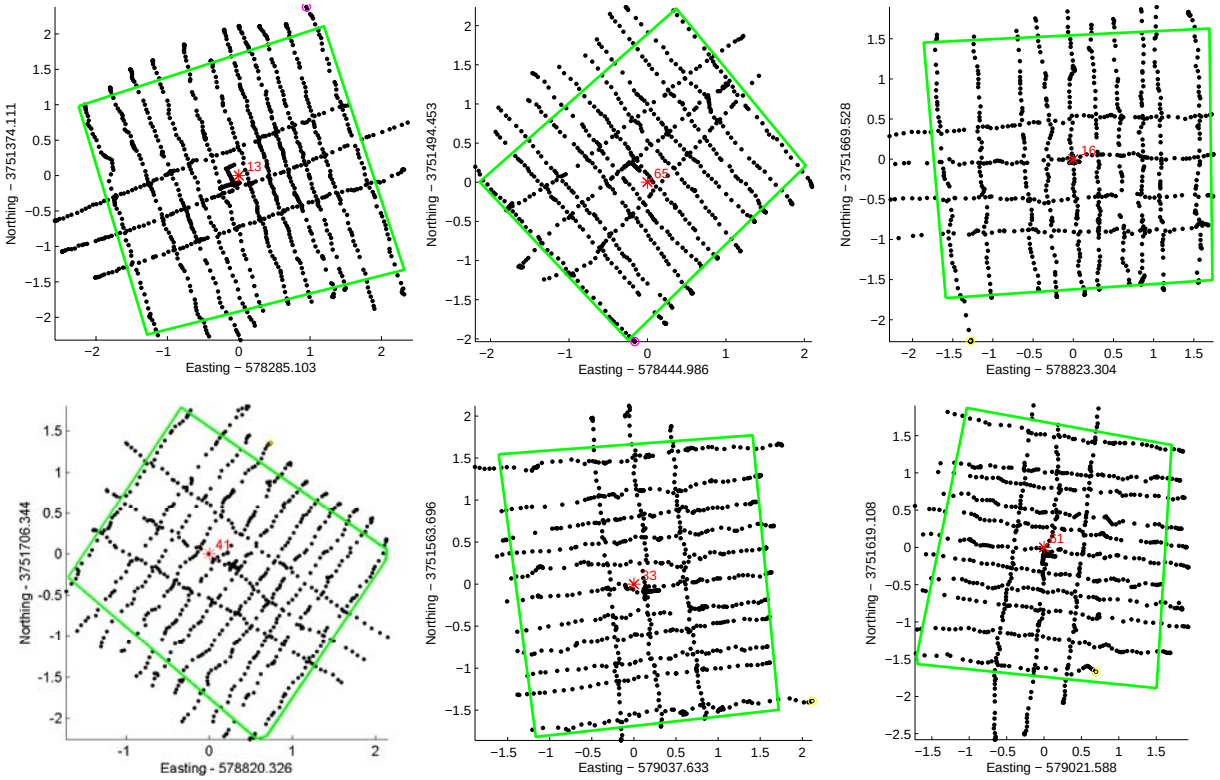

Figure 16. The six anomalies used to calculate the data point density metric (anomalies SW-13, SW-65, SE1-16, SE1-41, SE2-33 and SE2-61).

5.1.5 Location accuracy of interpreted anomalies

Objective: Better than 15 cm.

Performance: Met for 77% of items.

Figure 17 compares the fitted and ground-truth positions for all cued-interrogation anomalies, including the GPO, but excluding items identified as geology, soil or no-find. The fitted positions have a very small bias in both Easting (0.27 cm) and Northing (-1.8 cm). Approximately 57% are within 10 cm of the ground-truth location and 77% are within 15 cm. The GPO items tend to cluster in the SE quadrant of the plot indicating that some of the RTS set-ups may have been slightly biased relative to the coordinate system used for the ground-truth.

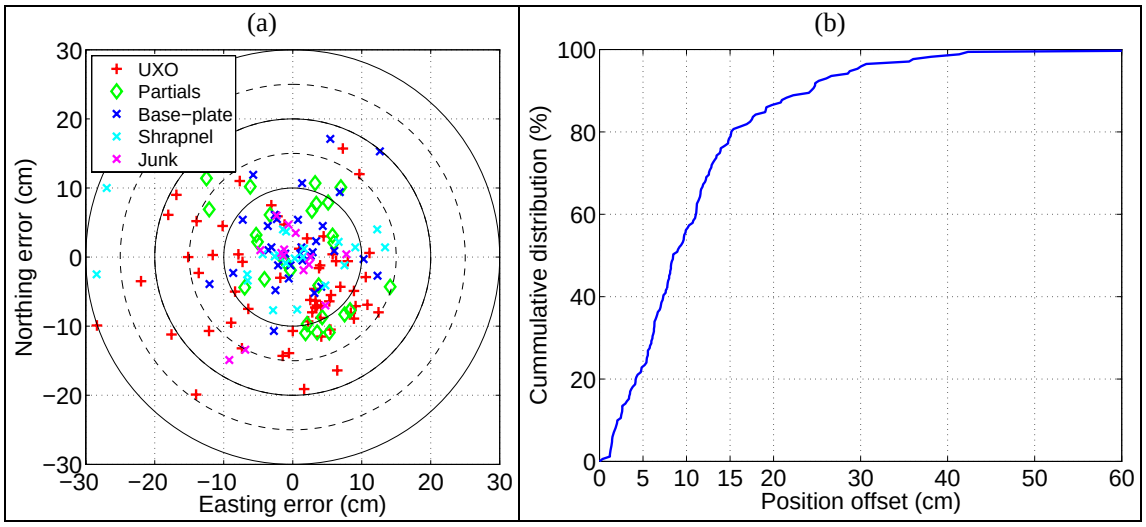

Figure 17. Comparison of ground-truth versus fitted positions for all items measured at Camp Sibert, including the GPO: (a) Scatter plot of position offset in Easting and Northing; and (b) Cumulative distribution of the difference between ground-truth and fitted positions.

5.1.6 Depth accuracy of interpreted anomalies

Objective: Better than 10 cm.

Performance: Met for 73% of items.

Figure 18 compares the fitted and ground-truth depths for all cued-interrogation anomalies, including the GPO, but excluding items identified as geology, soil or no-find. Approximately 73% are within 10 cm of the ground-truth location and 94% are within 20 cm. The most significant outliers comprise small pieces of shrapnel that are fit too deep and one 4.2” mortar that was fit too shallow. The reason for this shallow solution is explored further in the companion demonstration document on the data processing and interpretation.

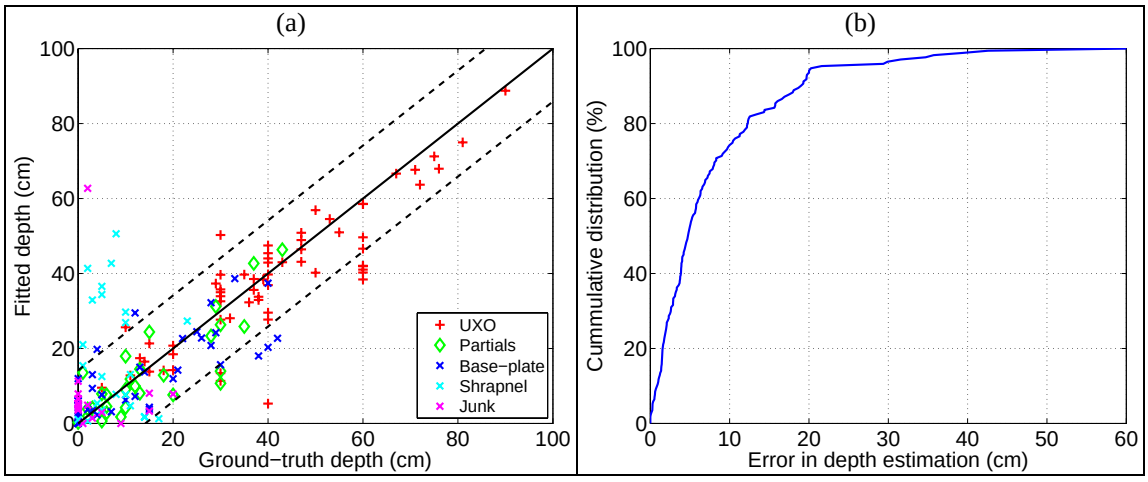

Figure 18. Comparison of ground-truth versus fitted depths for all items measured at Camp Sibert, including the GPO: (a) Ground-truth versus fitted depth; and (b) Cumulative distribution of the difference between ground-truth and fitted depth.

6. COST ASSESSMENT

6.1 Cost Reporting

Cost categories for this demonstration are mobilization, field survey, data analysis, demobilization, and reporting. These costs were tracked throughout the demonstration and are presented in table 13 (fully burdened). The data collection costs include three extra days on site to collect full-coverage data over the GPO and part of the SW area, as well as a number of transects collected to characterize the soil background of the site. The data processing costs include about two-days of work implementing the RTS set-up corrections, and the processing of the full-coverage data.

Table 13. Fully burdened costs for the demonstration and the pre-mobilization tests conducted in Ashland.

Categories	Pre-mob testing	Mobilization	Data collection	Data processing	Reporting	Total (excluding testing)	Total
Labor	$ 12,229.24	$ 8,710.48	$21,825.19	$ 13,611.96	$6,574.50	$50,722.14	$ 62,951.38
Equipment	$ 4,238.49	$ 2,658.44	$ 6,054.99	$ -	$ -	$ 8,713.42	$ 12,951.91
Travel	$ 3,085.04	$ 3,923.23	$ 6,148.81	$ -	$ -	$10,072.04	$ 13,157.08
Matls and Supplies	$ 537.94	$ 948.28	$ 16.26	$ -	$ -	$ 964.54	$ 1,502.49
Std ODCs	$ 1,068.38	$ 805.66	$ 1,839.01	$ 561.71	$ 293.99	$ 3,500.38	$ 4,568.76
Total	**$ 21,159.09**	**$ 17,046.09**	**$35,884.27**	**$ 14,173.68**	**$6,868.49**	**$73,972.54**	**$ 95,131.62**

6.2 Cost Analysis

Any cost analysis and comparisons against base-line technologies will be conducted in cooperation with the ESTCP Program Office.

7. REFERENCES

Archives Search Report Findings, Camp Sibert, Etowah and St. Clair Counties, Alabama, Site Nos. 104AL005700, US Army Corps Of Engineers, St. Louis District, July 1993.

Bell. T., 2005, Geo-location Requirements for UXO Discrimination: Paper prepared for UXO Location Workshop, Annapolis, May 2005.

Billings, S. D., Pasion, L. R., Beran, L., Oldenburg, D., Sinex, D., Song, L., Lhomme, N., 2007a, Demonstration Report for the Former Lowry Bombing and Gunnery Range, ESTCP MM-0504: Practical Discrimination Strategies for Application to Live Sites.

Billings, S. D., Pasion, L. R. and Oldenburg, D., 2007b, Sky Research/University of British Columbia (UBC) ESTCP Discrimination Study, Data Processing Plan, ESTCP MM-0504: Practical Discrimination Strategies for Application to Live Sites

Demonstration Plan, ESTCP UXO Discrimination Study. ESTCP. Final. March 2007.

8. POINTS OF CONTACT

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Project Lead Signature:

APPENDIX A: QUALITY ASSURANCE PROJECT PLAN (QAPP)

A.1 Purpose and Scope of the Plan

The purpose of this plan is to outline the quality assurance procedures for this project.

A.2 Quality Assurance Responsibilities

The QA Officer for this demonstration will be Dr Stephen Billings of Sky Research. Dr Billings is a geophysicist with over 8 years experience with QA of geophysical data. He will oversee the demonstration, assure compliance with the demonstration plan, and attest to the results.

A.3 Data Quality Parameters

The following calibration/standardization tests are performed at least once each day:

- Verification of RTS or GPS setup;
- Background, spike, background test;
- Time calibration of the EM-63 to the GPS/RTS;
- Time calibration of the IMU to the GPS/RTS; and
- Measurement of coordinate systems of the IMU and EM-63 coil.

Verification of Robotic Total Station or GPS set-up

For the Robotic Total Station to provide accurate absolute positions the gun needs to be either

1) Set up at a known location and a back-site made to a known point to establish the orientation of the gun; and
2) Set up at an unknown location and a resection made to two known points to establish the position and orientation of the gun;

After set-up, a measurement needs to be made over another known point (confirmation point). The 3-D position (Easting, Northing and Elevation) of the measured and actual locations of the confirmation point are compared and must agree to within 1 cm for the geophysical surveying to commence.

The procedure is similar with the GPS, except in that case, the base-station is typically established on a known point. A measurement is then taken on a second known point, which must lie within < 5 cm for the geophysical surveying to commence.

Static background calibration and spike test

For the EM a static background and spike test is performed twice daily, prior to collecting data and after completion of data collection. This test monitors the instrument background readings, monitors for electronic drift, identifies potential interference, and determines the repeatability of measurements over a standard test item. The standard test item is a wire loop with about a 10 cm diameter.

With the instrument on a plastic saw horse at an elevation of a least 1.5 meters above ground a background measurement is recorded for a period of one minute (Figure A-1). A standard test item is then placed under the center of the coil and an additional minute of data is recorded. The test-item is removed and an additional one minute of background data is collected.

Readings for the response of the standard test item should be within 20% after subtraction of the sensor baseline response.

The full static-spike-static test is conducted at the start and end of each day. A static background check will be conducted after surveying each anomaly (i.e. where the EM-63 will be place on the plastic saw-horses and will collect data for 30 seconds).

Figure A-1. EM-63 cart on sawhorses for static background test at the FLBGR. RTS prism is mounted here on pole for better visibility range.

Sensor height check

The distance from ground to the center of the coil will be recorded at the start and end of each day as this will vary slightly depending on the degree to which the air suspension is pumped.

Time calibration and positioning accuracy test

The procedure below will be utilized at the site to determine the time-lag between sensor and positioning unit, define the spatial accuracy of the data as well as the repeatability of the sensor readings.

1. A 5 meter long straight-line transect will be established with the positions of the endpoints and midpoint logged via RTS.
2. Wherever possible the traverse line will be oriented North–South. The EM-63 will be operated over the transect each day following these steps:
   a. A small metallic ball will be placed over the midpoint.
   b. The operator will log data along the same path, first traveling north, then returning south.
   c. The operator will log data along the same path, first traveling north at a slow pace, then returning south at a significantly more rapid pace.
3. All data lines will be examined by the QC geophysicist on a daily basis. These data will be examined to determine the repeatability of the pin-flag anomaly amplitude and the repeatability of the positional location of the amplitude peak.

Time calibration of IMU

To determine the extent and consistency of any potential time-lag beween the IMU and the positioning system the following test will be conducted at the twice daily:

The operator will stand facing North and will record a line of data while a second person rolls the instrument to the right and then to the left. A second line of data will be recorded with the instrument pitched forwards and then backwards.

For the roll-test, time alignment between the RTS and the IMU is obtained by finding the time-difference that causes maximum correlation between sin(roll) and the change in Easting value. The pitch test is used to verify the value returned by the roll test and uses correlation between sin(pitch) and the change in Northing value.

Verification of IMU and sensor frame-of-reference.

To determine any orientation difference between the IMU and the sensor system the following “RTS corners” test will be conducted at the start and end of each day:

The EM-63 cart will be horizontal and stationary and 15 seconds of data (RTS, IMU, and sensor) will be collected. The RTS prism will then be taken off the sensor and put on a range pole. The location of each of the four corners of the coil will then be recorded.

Any-time the IMU is remounted, or the height of the prism or location of the sensor is changed, a second RTS corners test will be performed with EM-63 cart rolled at an angle of about 10 degrees.

From these calibration measurements we find the plane that provides the best fit to the measured locations of the corners. The pitch and roll of that plane is then compared to the values measured by the IMU. The difference in these two values provides an indication of the orientation difference between the coil and IMU frames of reference.

A.4 Calibration Procedures, Quality Control Checks, and Corrective Action

The following procedures and logs are used to maximize standardization, repeatability, and control of mapping activities:

- Calibration (as per previous section) – Each sensor will be field-tested daily to ensure that it is operating properly.

- Data Processing Log - All data from the field are run through a standard data-processing procedure. This procedure is the same for all data and is tracked with the Data Processing Log. This log documents all coordinate transformations, visual data-quality checks, statistical data-quality checks, survey-coverage statistics, interpolation parameters, etc.

- Field Activity Log - This log is filled out by each crew chief and details all activities of the survey. This is a daily log and contains observations about crew performance, sensor performance, site conditions, and weather changes.

- Survey control log: The set-up locations of the Robotic Total Station and any back-site, resection and confirmation points are recorded in this log.

A.5 Calculation of Data Quality Indicators

Data quality indicators will be computed directly from the performance metrics and goals established in the Demonstration Plan document. As described above, these metrics will be incorporated into the metadata for each datasets, and will become an established permanent element of each.

A.6 Performance and System Audits

All project activity will be reviewed on an ongoing basis by the QA Officer and included in the weekly QA status report. Performance and system audits will be implemented on an irregular basis by the Principal Investigator to assure that the procedures specified in this QA/QC plan are being implemented.

A.7 Quality Assurance Reports

The QA Officer will provide weekly quality assurance reports as described above, and produce a final QA report at the finalization of field activities.

A.8 Data Format

Most data collected during this demonstration will be in digital format stored using industry standard ASCII protocols.

APPENDIX B: SUMMARY OF CORRECTIONS MADE TO POSITIONS AND AZIMUTH

There were three complications with the ground-control points that needed to be corrected post-survey:

1) The location of Monument 189 that was provided to all demonstrators was incorrect, but due to its extensive use the Program Office has decided to base the demonstration coordinates on its originally reported erroneous location;
2) Monument 189 was used as a base position or back-site point for some set-ups including to establish the new control points 826 and 827;
3) The coordinates for monument 824 were entered incorrectly into the RTS and this problem was not discovered until the end of the second day of surveying.

For SE-1 and SE-2 anomalies, monument 189 was never used in a set-up and the recorded RTS positions were all correct. Those positions were "corrected" by subtracting 11.37 cm from the Easting and adding 22.34 cm to the Northing, so that they would agree with the shifted coordinate systems used for the demonstration. For the SW area and the GPO, the corrections were more complicated and there were three different base-station/back-site/resection combinations that were used.

Correction strategy 1 (Base at 826, back-site to 189)

This was the set-up used on May 8, 10 and 11 2007 and was used to collect data over the GPO (both cued and full-coverage), over anomalies SW-1, -8 and -61 and of the full-coverage data collected in the SW area. The locations of both 826 and 189 were incorrect (see Table C-1). To correct the data the following procedure was applied:

1) Translate coordinates by X = -578331.204 and Y = -3751366.579;
2) Rotate coordinates counter-clockwise by 0d 31' 17";
3) Translate coordinates by X = 578332.456 and Y = 3751364.944
4) Translate coordinates again by X = -0.1137 and Y = 0.2234

After step-3, the coordinates are in their "correct" locations. Step 4 is applied to move the coordinates so that they agree with the shifted coordinate system adopted by the Program Office.

Table B- 1. Erroneous and actual locations of monuments 189 and 826.

Survey monuments	Easting	Northing	Used for
189 (erroneous)	578486.975	3751490.960	Backsite
826 (erroneous)	578331.204	3751366.579	Base
189 (correct)	578487.089	3751490.737	Backsite
826 (correct)	578332.456	3751364.944	Base

Correction strategy 2 (Base at 826, back-site to 824)

This was the set-up used on the first day of surveying (May 1 2007) and effects 6 anomalies in the SW area (anomalies SW-4, -7, -9, -13, -17 and -22). The locations of both 824 and 826 were incorrect (Table C-2). To correct the data the following procedure was applied

1) Translate coordinates by X = -578671.501 and Y = -3571528.055;
2) Rotate coordinates clockwise by 139d 54' 29";
3) Translate coordinates by X = 578332.456 and Y = 3751364.944
4) Translate coordinates again by X = -0.1137 and Y = 0.2234

After step-3, the coordinates are in their "correct" locations. Step 4 is applied to move the coordinates so that they agree with the shifted coordinate system adopted by the Program Office.

Table B- 2. Coordinates used for base monument 826

Survey monuments	Easting	Northing	Used for
824 (erroneous)	578472.237	3571508.363	Backsite
826 (erroneous)	578671.501	3571528.055	Base
824 (correct)	578472.237	3751508.363	Backsite
826 (correct)	578332.456	3751364.944	Base

Correction strategy 3 (Base at 827, resection using 824 and 826)

This was the set-up used on the second day of surveying (May 2 2007) and effects 22 anomalies in the SW area (anomalies SW-15, -16, -20, -23, -24, -25, -28, -32, -33, -34, -35, -37, -39, -40, -41, -47, -48, -53, -57, -58, -60, -64). The locations of 824, 826 and 827 were incorrect (Table C-3). To correct the data the following procedure was applied

1) Translate coordinates by X = -578655.082 and Y =-3571497.965;
2) Rotate coordinates clockwise by 139d 54' 04";
3) Translate coordinates by X = 578325.675 and Y = 3751398.545
4) Translate coordinates again by X = -0.1137 and Y = 0.2234

After step-3, the coordinates are in their "correct" locations. Step 4 is applied to move the coordinates so that they agree with the incorrect location of monument 189.

Table B- 3. Coordinates used for base monument 827

Survey monuments	Easting	Northing	Used for
824 (erroneous)	578472.237	3571508.363	Resection
826 (erroneous)	578671.501	3571528.055	Resection
827 (erroneous)	578655.082	3571497.965	Base
824 (correct)	578472.237	3751508.363	Resection
826 (correct)	578332.456	3751364.944	Resection
827 (correct)	578325.675	3751398.545	Base

APPENDIX C: DAILY ACTIVITY LOG

Monday, April 30

On site: Billings, Kingdon and Rogers

Daily Activity Summary:

- Met at 7:30 AM in hotel lobby in Birmingham. Returned to airport to switch rental car to Kingdon as driver, picked up equipment from FedEX, drove to Gadsden
- Arrived at trailer location and met Greg Nivens, Parsons, who provided a quick tour of the site and survey locations. Picked up lithium ion batteries at trailer site.
- Purchased additional supplies and returned to hotel to check in, assemble cart , charge batteries, and prepare tarps and equipment for starting survey Tuesday.
- Finished preparing equipment at 7pm.

Tuesday, May 1

On site: Billings, Kingdon and Rogers

Daily Activity Summary:

- Arrive at Parsons trailer at 7:15 am
- Issues identified and resolved prior to survey start:
    1. EM-63 logger was reporting 1200 hours of available space rather than the normal 70 or so minutes. This behavior was noted on the last day in Ashland and G63 files were not being logged; related to full buffers on the logger. Deleting all files on the logger fixed the issue.
    2. EM-63 did not seem to have Rx turned on, seemed to be associated with the new IMU batteries; perhaps not burned in through a series of charge/discharge cycles. Switched to orange geonics battery to resolve the issue.
    3. Control points on the Southwest grid were placed too close together to perform a resection with the RTS. Needed to set up over one control point and shoot in an additional control point closer to the cued area that we were working in.
    4. EM-63 data logger internal battery dead around 3:30 pm, may need charge it from inverter and car battery over lunch to extend the working time. Kevin to check with Jon Jacobson to see what was done at Lowry to get power to the 63 logger for a longer time.
    5. USACE doesn't allow stakes to be pounded into the ground to hold tarps down. Need to investigate other possibilities…sandbags?, wood doweling/fiberglass around edges?
- Collected data over 8 of the marked items over approximately 3 hours of data collection once all issues were resolved.

- Leave Connex at 4:45 pm.
- Purchased additional field supplies, including alternatives to use instead of stakes to secure the tarps.
- Need to bring laptop battery charger (for charging off of inverter), inverter and charger for the EM-63 logger for subsequent field days.

Wednesday May 2

On site: Billings, Kingdon and Rogers

Daily Activity Summary:

- Arrive at connex at 6:15 am
- Issues identified and resolved prior to survey start:

    1. RTS setup issues. Values of the checked point did not coincide with the measured value after logging the point post resection. Required doing 3 resections before getting acceptable values. Additional control points should improve the situation.
    2. EM-63 data logger battery life is the determining factor in the amount of data that can be collected. Battery dead around 3pm and requires overnight to charge. Ordered a new heavy duty battery that will be delivered to hotel on Friday. Will install and have ready for use on Saturday's surveying.

- Collected cued data over 23 of the marked items on the southwest grid.
- Left connex at 4:15 pm

Thursday, May 3

On site: Billings, Kingdon and Rogers

Daily Activity Summary:

- Arrive at connex at 6:45 am
- Issues identified and resolved prior to survey start:

    1. Discovered that one of the control points was entered incorrectly in the RTS gun which probably explains the difficulties that we were having performing resections on the first 2 days. Incorrect point was 824, the correct point was called S824 in the SIBERT job.
    2. EM-63 data logger was again the determining factor in the amount of data that could be collected. Battery died around 3pm and requires overnight to charge. Steve ordered a new heavy duty battery that will be delivered to hotel on Friday. Will install and have ready for use on Saturday's surveying.

3. USACE safety officer cannot allow us to use any kind of stakes to hold tarps in place. Used water bottles temporarily, will try duct taping sand filled Ziploc bags to corners of tarp tomorrow.

- Collected cued data over 36 of the marked items on the southwest grid. Finished cued-interrogation items on the Southwest grid

- Shot in additional survey control points (828,829,830) for future work on the two areas
- Closer to the connex/test strip area (approximately 1.5 hours to complete)

- Left connex at 4:00 pm

Friday May 4

On site: Billings, Kingdon and Rogers

Daily Activity Summary:

- Arrive at connex at 6:45 am

- Collected cued data over 31 of the marked items on the southeast grid closest to the pond.

- Shot in additional survey control points (831,832) for future work on the two southeast areas (approximately half an hour)

- New EM-63 console battery arrived. Didn't appear to have the same trickle charge connection that was on the original battery but it looks like it can still be powered

- No surveys planned for Saturday May 5, resume on Sunday May 6. Turned key for the property gate over to Berkley group who do plan to survey on Saturday. They will return to us Saturday night for Sunday surveying

- Left connex at 1:45 pm

- Steve Billings return to Vancouver; Dalrymple arrive to provide field support..

Saturday May 5

On site: Kingdon, Dalrymple and Rogers

Daily Activity Summary:

- Arrive at connex at 10:45 am

- Collected data at test strip and setup RTS, and introduction to work for Pete Dalrymple, new team member.

- Collected cued data over 27 of the marked items on the southeast grid closest to the pond.

- Setup base over point 831, back-site to 825. Confirmation recorded as 1832:

1832		832	
N	3751677.864	E	578813.347
N	3751677.857	El	158.419q
E	578813.342	El	158.198

- New EM-63 console battery appears to have charged properly by opening the console and replacing the juniper battery. Lasted all (of the partial) day. Will continue to monitor battery life tomorrow.

- Left connex at 5:45 pm

Sunday May 6

On site: Kingdon, Dalrymple and Rogers

Daily Activity Summary:

- Arrive at connex at 7:00 am

- Collected data at test strip and setup RTS for final 11 targets in the southeast areas near the pond.

- Setup base over point 832, back-site to 825. Confirmation recorded as 1831:

1831		831	
N	3751641.392	N	3751641.367
E	579011.960	E	579011.966
El	157.334	El	157.141

- Collected cued data over 11 of the marked items on the southeast grid closest to the pond.
- Tear down and set up RTS for location near southeast area furthest from pond

- Setup base over point 831, back-site to 825. Confirmation recorded as 1832:

1832		832	
N	3751677.850	N	3751677.857
E	578813.331	E	578813.347
El	158.414	El	158.198

- Collected data over 35 of the marked items on the southeast grid furthest from the pond. Collected calibrations and test strip data.

- Left connex at 5:30 pm

Monday May 7

On site: Kingdon, Dalrymple and Rogers

Daily Activities Summary:

- Arrive at connex at 6:30 am
- Collected data at test strip and setup RTS for final targets in SE2 area
- Setup base over point 831, back-site to 832. Confirmation recorded as 1829:

1829		829	
N	3751750.439	N	3751750.378
E	578693.123	E	578693.131
El	159.719	El	159.664

- Had to shoot in new location (834) for line of site to target se2-29 that was obscured behind a small shed when the base station was at point 831.
- Had to move RTS base station to 832 recollect SE1-12 since that target was obscured by trees while the base station was at point 831
- Collected data over final 31 marked items in SE2 and the recollect of SE1-12.
- Scoped out GPO, flags have now been added and all points in the GPO should be surveyable from a base station setup at point 826. Note that point 826 will need to be reshot since it was initially recorded based on an incorrect point at 824. Flag has been added for SW08 which was not flagged during the initial survey of the SW area. That target can be covered from the RTS base station at 826 as well. Other two points not previously recorded (SW01, corner stake; SW61, GPS base station) will be surveyed after the GPO is completed.
- One of the orange EM-63 battery chargers died. Not clear why but should be ok with one as long as always keep one battery charging when not in use.
- Left connex at 4:00 pm

Tuesday May 8

On site: Kingdon, Dalrymple and Rogers

Daily Activity Summary:

- Arrive at connex at 7:15 am
- Collected data at test strip and setup RTS in the southwest area, need to setup base over point 826 for coverage of GPO and remaining items from SW area
- Needed to re-establish point 826 correctly since it was initially based on errorneous entered control points.
- Setup base over point 189, back-site to 823. Confirmation recorded as S1824:

S1824		S824	
N	3751508.708	N	3751508378
E	578472.290	E	578472.237
El	167.516	El	167.452

- Now shoot in point 826 again to get correct value, this time called S826:

S826	
N	3751366.579
E	578331.290
El	163.075

- Next, Setup base over point S826, back-site to 189. Confirmation recorded as S2824:

S2824		S824	
N	3751508.702	N	3751508378
E	578472.213	E	578472.237
El	167.784	El	167.452

- Cued survey over 38 items in the GPO

- Collected remaining 3 items from the SW area:
  1) SW01-corner stake (no rebar present though, may be a legitimate target), barely able to maintain line of site with RTS but made sure postitions were recorded.
  2) SW08-flag missing from original survey, collected at newly flagged location.
  3) SW61-GPS antenna setup previously, rebar in ground looks like it might have been the item picked.

- Drive Teal Rogers to Birmingham, returns to Ashland tomorrow.

- Left connex at 6:15 pm

Wednesday May 8

On site: Kingdon and Dalrymple

Daily Activities Summary:

- Arrive at connex at 7:15 am

- Collected data at test strip and setup RTS in SE2 area. Reaquired cued data over eleven items in SE2 that were lost when the DAS did not save data on Monday May 7. Also moved RTS to reacquire SE1-12 which was lost by the DAS issue as well.

- Talked with Len Pasion about the best approach for full coverage data given the time remaining. We agreed that the highest target density would be the GPO so we will start

on that tomorrow morning and should be able to complete it if all goes well. Talked with the Berkley staff and they had also done full coverage over the GPO.

- In terms of the other areas, there isn't time for any substantial full coverage and since Len was interested primarily in the geology of the site, we plan to collect a series of 4 line transects (0.5 line spacing) over each area.
- Plan to put the instrument up on sawhorses every 20 minutes for a background measurement.
- Started on the SE1 area after the recollects today.
- We borrowed one of the Berkley string spools and to use as a guide to collect 4 approximately parallel lines. Had some DAS issues where the DAS kept hanging up part way through a line. Collected one 4 line transect (in the same direction as Berkley was surveying).
- We plan to get to the site early tomorrow and collect data along another 4 line transect in that same direction and 3 sets of 4 line transects in a perpendicular direction before the Berkley team arrives.
- After finishing the 4 line transects on SE1, we'll do full coverage of the GPO. Following that, if time allows, collect 4 line transects over the SW and SE2 areas.
- It may be possible to collect some data Friday morning but, packing up the equipment for demob will take some time, so expect to complete data collection tomorrow.
- Purchased a plastic measuring tape for full coverage survey of GPO on the following day.
- Left connex at 3:45 pm

Thursday May 9

On site: Kingdon and Dalrymple

Daily Activity Summary:

- Arrive at connex at 6:30 am
- Collected data at test strip and setup RTS in SE1 area. Completed series of 4 line transects on SE1 area so that Len can evaluate geology. Used the Berkley string spools to try and keep the long lines parallel. Collected most of the data before Berkley team arrived on site and kept at least 50 meters distance from their team during surveying.
- Full coverage of GPO at 0.5m line spacing in the afternoon, used spray paint at ~10m intervals along track to try and keep lines as parallel as possible.
- Purchase more spray paint for additional full coverage survey Friday am over a portion of the SE1 area also covered by Berkley.
- Left connex at 5:00 pm

Friday May 10

On site: Kingdon and Dalrymple

Daily Activity Summary:

- Arrive at connex at 6:45 am
- Collected data at test strip and setup RTS in GPO area. Recollected cued data over 2 anomalies (002 and 024). Because RTS needed to be setup near GPO for recollectes, decided to also collect full coverage data on SW area rather than SE1
- Continued full coverage east of the GPO for approximately 100 feet at 0.5m line spacing, finished approximately 11:30am. Used spray paint at ~10m intervals along track to try and keep lines as parallel as possible.
- Dissassemble and pack gear and transport to Fed EX for return shipment.
- Left connex at 3:45
- Left FedEx at 5:15

APPENDIX D: FILE TRACKING SPREADSHEET AND INITIAL QC OF DATA

File	Type	Anomaly	Comment	Cart	Logger
May 1 2005			**7 anomalies**		
P1707121S.pos	Static-spike-static				
P1707121T.pos	Calibration Line				
P1707121U.pos	Four corners		A little bit of movement during collection: also points were done in the wrong order. Should be front-left, rear-left, rear-right, front-right (we did rear-left, front-left, front-right, rear-right)	Kingdon	Billings
P1707121V.pos	Empty			Kingdon	Billings
P1707121W.pos	Slew			Kingdon	Billings
P1707121X.pos	Static			Kingdon	Billings
P1707121Y.pos	Cued-interrogation	SW-09	Static background was last measurement in file: Removed a few spikes in the top-coil (about 11 of them). Not much of an anomaly, and it is off-center. I believe this was an emplaced round (due to disturbed soil)'	Kingdon	Billings
P1707121Z.pos	Static			Kingdon	Billings
P1707121AA.pos	Cued-interrogation		RTS turned off and had to recollect	Kingdon	Billings
P1707121BB.pos	Cued-interrogation	SW-04	Strong anomaly. Removed one spike in IMU data. In processing, removed a few EM-spikes. Big strong anomaly a little offset from center	Kingdon	Billings
P1707121CC.pos	Static			Kingdon	Billings
P1707121DD.pos	Cued-interrogation	SW-07	Strong anomaly. Removed two EM spikes in processing.	Kingdon	Rogers
P1707121EE.pos	Static			Kingdon	Rogers
P1707121FF.pos	Cued-interrogation	SW-13	Strong anomaly. One negative spike removed	Kingdon	Rogers
P1707121GG.pos	Static			Kingdon	Rogers
P1707121HH.pos	Cued-interrogation	SW-15	Strong anomaly. One negative spike removed. Missed one line near the anomaly center. Was originally listed as SW-18	Kingdon	Rogers
P1707121II.pos	Static			Kingdon	Rogers
P1707121JJ.pos	Static			Billings	Rogers
P1707121KK.pos	Cued-interrogation	SW-22	Small anomaly. 8 spikes removed from top-coil data	Billings	Rogers
P1707121LL.pos	Static			Billings	Rogers
P1707121MM.pos	Cued-interrogation	SW-17	Strong anomaly. Removed 7 spikes from top-coil data. Anomaly is just covered by data, need to extend lines slightly further	Billings	Rogers
P1707121NN.pos	Static			Billings	Rogers
P1707121OO.pos	Cued-interrogation		EM-63 battery ran out	Billings	Rogers
P1707121PP.pos	Static			Kingdon	Billings
P1707121QQ.pos	Cued-interrogation		EM-63 logger battery went flat.	Kingdon	Billings
			Have to finish the day early due to EM-63 logger battery		
May 2 2005			**23 anomalies (one was a repeat from yesterday)**		
P1707122A.pos	Static-Spike-Static			Kingdon	Billings
P1707122B.pos	Calibration line			Kingdon	Billings

File	Type	Anomaly	Comment	Cart	Logger
P1707122C.pos	Four corners		Had to remove one bad line at end of pos file. Last measurement does not make any sense, can't use for 4 corners estimation	Kingdon	Billings
P1707122D.pos	Slew test			Kingdon	Billings
P1707122E.pos	Static			Kingdon	Billings
P1707122F.pos	Cued-interrogation	SW-25		Kingdon	Billings
P1707122G.pos	Static		IMU looks to drifting	Kingdon	Billings
P1707122H.pos	Cued-interrogation	SW-16		Kingdon	Billings
P1707122I.pos	Static		No RTS	Kingdon	Billings
P1707122J.pos	Cued-interrogation	SW-33		Kingdon	Billings
P1707122K.pos	Static		IMU looks to be drifting	Kingdon	Billings
P1707122L.pos	Cued-interrogation	SW-15		Kingdon	Billings
P1707122M.pos	Static			Kingdon	Billings
P1707122N.pos	No EM-data?			Kingdon	Billings
P1707122O.pos	Cued-interrogation	SW-34		Kingdon	Billings
P1707122P.pos	Static			Kingdon	Billings
P1707122Q.pos	Cued-interrogation	SW-20		Kingdon	Billings
P1707122R.pos	Static			Kingdon	Billings
P1707122S.pos	Cued-interrogation	SW-48		Kingdon	Billings
P1707122T.pos	Static		Doesn't display RTS and sen	Kingdon	Billings
P1707122U.pos	Static			Kingdon	Billings
P1707122V.pos	Cued-interrogation	SW-36	Part of anomaly, but no RTS	Kingdon	Billings
P1707122W.pos	Cued-interrogation	SW-36	Start anomaly but then toughbook battery dies. Manually join with X and delete last line in W	Kingdon	Billings
P1707122X.pos	Cued-interrogation	SW-36	Finish previos anomaly	Kingdon	Billings
P1707122Y.pos	Static			Kingdon	Billings
P1707122Z.pos	Cued-interrogation	SW-41		Kingdon	Billings
P1707122AA.pos	Static			Kingdon	Billings
P1707122BB.pos	Cued-interrogation	SW-47	Looks like static is line 1	Kingdon	Billings
P1707122CC.pos	Static			Kingdon	Billings
P1707122DD.pos	Cued-interrogation	SW-53		Kingdon	Billings
P1707122EE.pos	Static		One spike in IMU removed	Kingdon	Billings
P1707122FF.pos	Cued-interrogation	SW-35		Kingdon	Billings
P1707122GG.pos	Static			Kingdon	Billings
P1707122HH.pos	Cued-interrogation	SW-32		Kingdon	Billings
P1707122II.pos	Static		No RTS	Kingdon	Billings
P1707122JJ.pos	Static			Kingdon	Billings
P1707122KK.pos	Cued-interrogation	SW-60	RTS not locked during pitch lines	Kingdon	Billings
P1707122LL.pos	Static			Kingdon	Billings
P1707122MM.pos	Cued-interrogation	SW-40		Kingdon	Billings
P1707122NN.pos	Static			Kingdon	Billings
P1707122OO.pos	Static			Kingdon	Billings
P1707122PP.pos	Cued-interrogation	SW-57		Kingdon	Billings
P1707122QQ.pos	Empty?			Kingdon	Billings
P1707122RR.pos	Static			Kingdon	Billings
P1707122SS.pos	Cued-interrogation	SW-58		Kingdon	Billings
P1707122TT.pos	Static		IMU drifting, but looks like it is stablising	Kingdon	Billings

File	Type	Anomaly	Comment	Cart	Logger
P1707122UU.pos	Static			Kingdon	Billings
P1707122VV.pos	Cued-interrogation	SW-64		Kingdon	Billings
P1707122WW.pos	Static			Kingdon	Billings
P1707122XX.pos	Cued-interrogation	SW-28	One spike removed	Kingdon	Billings
P1707122YY.pos	Cued-interrogation	SW-23	Close to previous anomaly so no background	Kingdon	Billings
P1707122ZZ.pos	Part of anomaly		No RTS positions for most of the anomaly	Kingdon	Billings
P1707122AAA.pos	Cued-interrogation	SW-24		Kingdon	Billings
P1707122BBB.pos	Static			Kingdon	Billings
P1707122CCC.pos	Cued-interrogation	SW-37		Kingdon	Billings
P1707122DDD.pos	Static			Kingdon	Billings
P1707122EEE.pos	Cued-interrogation	SW-39		Kingdon	Billings
P1707122FFF.pos	Static		EM-63 data logger battery dies	Kingdon	Billings
			Have to finish the day early due to EM-63 logger battery		
May 3 2005			**36 anomalies (finish SW area except for a couple of straglers)**		
P1707123A.pos	Static-spike-static		IMU acting up/	Billings	Kingdon
P1707123B.pos	Ignore			Billings	Kingdon
P1707123C.pos	Calibration line		IMU acting up	Billings	Kingdon
P1707123D.pos	Four corners			Billings	Kingdon
P1707123E.pos	Slew			Billings	Kingdon
P1707123F.pos	Static			Billings	Kingdon
P1707123G.pos	Cued-interrogation	SW-31		Billings	Kingdon
P1707123H.pos	Cued-interrogation	SW-30		Billings	Kingdon
P1707123I.pos	Static			Billings	Kingdon
P1707123J.pos	4 lines of a file		RTS problem?	Billings	Kingdon
P1707123K.pos	Cued-interrogation	SW-29	Static as first line	Billings	Kingdon
P1707123L.pos	Cued-interrogation	SW-27	Static as last line	Billings	Kingdon
P1707123M.pos	Static			Billings	Kingdon
P1707123N.pos	Cued-interrogation	SW-26	Check this	Billings	Kingdon
P1707123O.pos	Static			Billings	Kingdon
P1707123P.pos	Cued-interrogation	SW-18		Billings	Kingdon
P1707123Q.pos	Static			Billings	Kingdon
P1707123R.pos	Cued-interrogation	SW-6	Static as last line	Billings	Kingdon
P1707123S.pos	Cued-interrogation	SW-3		Billings	Kingdon
P1707123T.pos	Static			Billings	Kingdon
P1707123U.pos	Cued-interrogation	SW-2		Billings	Kingdon
P1707123V.pos	Cued-interrogation	SW-5		Billings	Kingdon
P1707123W.pos	Static			Billings	Kingdon
P1707123X.pos	6 lines of an anomaly		RTS problem: backwards time-steps. Did the DAS crash?	Billings	Kingdon
P1707123Y.pos	Static		No POS data	Billings	Kingdon
P1707123Z.pos	Cued-interrogation	SW-10	Static as first line	Billings	Kingdon
P1707123AA.pos	Cued-interrogation	SW-11		Billings	Kingdon
P1707123BB.pos	Static			Billings	Kingdon
P1707123CC.pos	Cued-interrogation	SW-12	Last line… not turned off … deleted	Billings	Kingdon
P1707123DD.pos	Cued-interrogation	SW-14		Billings	Kingdon
P1707123EE.pos	Cued-interrogation	SW-19		Billings	Kingdon

File	Type	Anomaly	Comment	Cart	Logger
P1707123FF.pos	Static			Billings	Kingdon
P1707123GG.pos	Cued-interrogation	SW-21		Billings	Kingdon
P1707123HH.pos	Static		2 lines	Billings	Kingdon
P1707123II.pos	Cued-interrogation	SW-38		Billings	Kingdon
P1707123JJ.pos	Cued-interrogation	SW-44		Billings	Kingdon
P1707123KK.pos	Static		One bad point removed from EM-63	Billings	Kingdon
P1707123LL.pos	Final 3 lines of a file, or first 3?		New battery for toughbook	Billings	Kingdon
P1707123MM.pos	Static		One bad point removed from EM-63	Billings	Kingdon
P1707123NN.pos	Cued-interrogation	SW-51		Billings	Kingdon
P1707123OO.pos	Cued-interrogation	SW-50		Billings	Kingdon
P1707123PP.pos	Static			Billings	Kingdon
P1707123QQ.pos	Cued-interrogation	SW-46		Billings	Kingdon
P1707123RR.pos	Cued-interrogation	SW-45		Billings	Kingdon
P1707123SS.pos	Cued-interrogation	SW-43		Billings	Kingdon
P1707123TT.pos	Static			Billings	Kingdon
P1707123UU.pos	Cued-interrogation	SW-42		Billings	Kingdon
P1707123VV.pos	Static		One bad point removed from EM-63	Billings	Kingdon
P1707123WW.pos	Cued-interrogation	SW-49		Billings	Kingdon
P1707123XX.pos	Cued-interrogation	SW-55		Billings	Kingdon
P1707123YY.pos	Static		File not closed after static	Billings	Kingdon
P1707123ZZ.pos	Cued-interrogation	SW-52		Billings	Kingdon
P1707123AAA.pos	Cued-interrogation	SW-54	Static line was first line. Manually joined with BBB file	Billings	Kingdon
P1707123BBB.pos	Pitch lines from a previous anomaly			Billings	Kingdon
P1707123CCC.pos	Start or end of a file			Billings	Kingdon
P1707123DDD.pos	Static			Billings	Kingdon
P1707123EEE.pos	Cued-interrogation	SW-56		Billings	Kingdon
P1707123FFF.pos	Cued-interrogation	SW-59		Billings	Kingdon
P1707123GGG.pos	Static		No EM	Billings	Kingdon
P1707123HHH.pos	Static			Billings	Kingdon
P1707123III.pos	2 lines of a file			Billings	Kingdon
P1707123JJJ.pos	Cued-interrogation	SW-63	Removed some IMU data from line 14 to prevent the pitch_lines function from executing	Billings	Kingdon
P1707123KKK.pos	Cued-interrogation	SW-65		Billings	Kingdon
P1707123LLL.pos	Cued-interrogation	SW-67		Billings	Kingdon
P1707123MMM.pos	Cued-interrogation	SW-62		Billings	Kingdon
P1707123NNN.pos	Static		Break for lunch as battery died	Billings	Kingdon
P1707123OOO.pos	Static		Charge up EM-63 battery for final two anomalies	Kingdon	Billings
P1707123PPP.pos	Cued-interrogation	SW-66		Kingdon	Billings
P1707123QQQ.pos	Cued-interrogation	SW-68		Kingdon	Billings
P1707123RRR.pos	Static			Kingdon	Billings
			Early finish again due to EM-63 logger battery (new battery on order due to arrive tomorrow)		

File	Type	Anomaly	Comment	Cart	Logger
May 4 2007			**31 anomalies in SE1 area**		
P1707124SSS.pos	Static-spike-static		Stored it in the wrong directory, hence the name	Kingdon	Billings
P1707124TTT.pos	Calibration Line		Stored it in the wrong directory, hence the name	Kingdon	Billings
P1707124A.pos	Four corners			Kingdon	Billings
P1707124B.pos	Slew test		No RTS data for first line (sensor slew)	Kingdon	Billings
P1707124C.pos	Static			Kingdon	Billings
P1707124D.pos	Cued-interrogation	SE1-60		Kingdon	Billings
P1707124E.pos	Cued-interrogation	SE1-59		Kingdon	Billings
P1707124F.pos	Cued-interrogation	SE1-57		Kingdon	Billings
P1707124G.pos	Static			Kingdon	Billings
P1707124H.pos	Static			Kingdon	Billings
P1707124I.pos	Cued-interrogation	SE1-56		Kingdon	Billings
P1707124J.pos	Cued-interrogation	SE1-61		Kingdon	Billings
P1707124K.pos	Cued-interrogation	SE1-64		Kingdon	Billings
P1707124L.pos	Static			Kingdon	Billings
P1707124M.pos	Cued-interrogation	SE1-51		Kingdon	Billings
P1707124N.pos	Static			Kingdon	Billings
P1707124O.pos	Static			Kingdon	Billings
P1707124P.pos	Static			Kingdon	Billings
P1707124Q.pos	Cued-interrogation	SE1-62		Kingdon	Billings
P1707124R.pos	Static			Kingdon	Billings
P1707124S.pos	Cued-interrogation	SE1-65		Kingdon	Billings
P1707124T.pos	Cued-interrogation	SE1-66		Kingdon	Billings
P1707124U.pos	Static			Kingdon	Billings
P1707124V.pos	Static			Kingdon	Billings
P1707124W.pos	Cued-interrogation	SE1-68		Kingdon	Billings
P1707124X.pos	Cued-interrogation	SE1-67		Kingdon	Billings
P1707124Y.pos	Cued-interrogation	SE1-63		Kingdon	Billings
P1707124Z.pos	Cued-interrogation	SE1-53		Kingdon	Billings
P1707124AA.pos	Static			Kingdon	Billings
P1707124BB.pos	Cued-interrogation	SE1-50	Static as first line	Kingdon	Billings
P1707124CC.pos	Cued-interrogation	SE1-44		Kingdon	Billings
P1707124DD.pos	Cued-interrogation	SE1-43		Kingdon	Billings
P1707124EE.pos	Static			Kingdon	Billings
P1707124FF.pos	Part of a file		Only partial EM-63 data recorded	Kingdon	Billings
P1707124GG.pos	Static			Kingdon	Billings
P1707124HH.pos	Cued-interrogation	SE1-40		Kingdon	Billings
P1707124II.pos	Cued-interrogation	SE1-33		Kingdon	Billings
P1707124JJ.pos	Static			Kingdon	Billings
P1707124KK.pos	Cued-interrogation	SE1-32		Kingdon	Billings
P1707124LL.pos	Cued-interrogation	SE1-26		Kingdon	Billings
P1707124MM.pos	Cued-interrogation	SE1-24		Kingdon	Billings
P1707124NN.pos	Static			Kingdon	Billings
P1707124OO.pos	Static			Kingdon	Billings
P1707124PP.pos	Cued-interrogation	SE1-23		Kingdon	Billings

File	Type	Anomaly	Comment	Cart	Logger
P1707124QQ.pos	One line, probably aborted			Kingdon	Billings
P1707124RR.pos	Cued-interrogation	SE1-17		Kingdon	Billings
P1707124SS.pos	Cued-interrogation	SE1-21		Kingdon	Billings
P1707124TT.pos	Static			Kingdon	Billings
P1707124UU.pos	Cued-interrogation	SE1-20		Kingdon	Billings
P1707124VV.pos	Static			Kingdon	Billings
P1707124WW.pos	Static			Kingdon	Billings
P1707124XX.pos	Cued-interrogation	SE1-18		Kingdon	Billings
P1707124YY.pos	Cued-interrogation	SE1-30		Kingdon	Billings
P1707124ZZ.pos	Cued-interrogation	SE-39	Long gap in middle of survey due to RTS not locking onto prism	Kingdon	Billings
P1707124AAA.pos	Cued-interrogation	SE1-35		Kingdon	Billings
P1707124BBB.pos	One line, probably aborted			Kingdon	Billings
P1707124CCC.pos	Cued-interrogation	SE1-38		Kingdon	Billings
P1707124DDD.pos	Four lines		EM-63 logger died	Kingdon	Billings
P1707124EEE.pos	Static			Kingdon	Billings
			Early finish again due to EM-63 logger battery (new battery on order due to arrive tomorrow)		
May 5 2007			**27 anomalies (after a late start)**		
P1707125A.pos	Static-spike-static			Dalrymple	Kingdon
P1707125B.pos	Calibration Lane			Dalrymple	Kingdon
P1707125C.pos	DAS crash?		POS file is huge.	Dalrymple	Kingdon
P1707125D.pos	Four corners			Dalrymple	Kingdon
P1707125E.pos	Slew test		No sensor slew	Dalrymple	Kingdon
P1707125F.pos	Static			Dalrymple	Kingdon
P1707125G.pos	Cued-interrogation	SE1-45		Dalrymple	Kingdon
P1707125H.pos	Cued-interrogation	SE1-46		Dalrymple	Kingdon
P1707125I.pos	Static			Dalrymple	Kingdon
P1707125J.pos	Static			Dalrymple	Kingdon
P1707125K.pos	Cued-interrogation	SE1-9		Dalrymple	Kingdon
P1707125L.pos	Cued-interrogation	SE1-14		Dalrymple	Kingdon
P1707125M.pos	Cued-interrogation	SE1-28		Dalrymple	Kingdon
P1707125N.pos	Static			Dalrymple	Kingdon
P1707125O.pos	Cued-interrogation	SE1-37		Dalrymple	Kingdon
P1707125P.pos	Cued-interrogation	SE1-38		Dalrymple	Kingdon
P1707125Q.pos	Cued-interrogation	SE1-25		Dalrymple	Kingdon
P1707125R.pos	Static			Dalrymple	Kingdon
P1707125S.pos	Cued-interrogation	SE1-15		Dalrymple	Kingdon
P1707125T.pos	Cued-interrogation	SE1-11	A few spikes in the EM-63	Dalrymple	Kingdon
P1707125U.pos	Static		One spike	Dalrymple	Kingdon
P1707125V.pos	Cued-interrogation	SE1-6		Kingdon	Dalrymple
P1707125W.pos	Cued-interrogation	SE1-3		Kingdon	Dalrymple
P1707125X.pos	Static			Kingdon	Dalrymple
P1707125Y.pos	Static		EM3 response changes … like someone moved away from the sensor	Kingdon	Dalrymple

File	Type	Anomaly	Comment	Cart	Logger
P1707125Z.pos	Cued-interrogation	SE1-1		Kingdon	Dalrymple
P1707125AA.pos	Static			Kingdon	Dalrymple
P1707125BB.pos	Static			Kingdon	Dalrymple
P1707125CC.pos	Cued-interrogation	SE1-5		Kingdon	Dalrymple
P1707125DD.pos	Cued-interrogation	SE1-4		Kingdon	Dalrymple
P1707125EE.pos	Cued-interrogation	SE1-7		Kingdon	Dalrymple
P1707125FF.pos	Static			Kingdon	Dalrymple
P1707125GG.pos	Static			Kingdon	Dalrymple
P1707125HH.pos	Cued-interrogation	SE1-10		Kingdon	Dalrymple
P1707125II.pos	Cued-interrogation	SE1-19		Kingdon	Dalrymple
P1707125JJ.pos	Cued-interrogation	SE1-27		Kingdon	Dalrymple
P1707125KK.pos	Static			Kingdon	Dalrymple
P1707125LL.pos	Cued-interrogation	SE1-42	Spike removed from IMU	Kingdon	Dalrymple
P1707125MM.pos	Cued-interrogation	SE1-48		Kingdon	Dalrymple
P1707125NN.pos	Cued-interrogation	SE1-58		Dalrymple	Kingdon
P1707125OO.pos	Static			Dalrymple	Kingdon
P1707125PP.pos	Cued-interrogation	SE1-49		Dalrymple	Kingdon
P1707125QQ.pos	Cued-interrogation	SE1-47		Dalrymple	Kingdon
P1707125RR.pos	Static			Dalrymple	Kingdon
P1707125SS.pos	Cued-interrogation	SE1-52		Dalrymple	Kingdon
P1707125TT.pos	Cued-interrogation	SE1-54		Dalrymple	Kingdon
P1707125UU.pos	Cued-interrogation	SE1-55		Dalrymple	Kingdon
P1707125VV.pos	Static			Dalrymple	Kingdon
P1707125WW.pos	Static-spike-static		Static and spike	Dalrymple	Kingdon
P1707125XX.pos	Static-spike-static		Final static	Dalrymple	Kingdon
P1707125YY.pos	Calibration lane			Dalrymple	Kingdon
			No limitations today apart from a late start		
May 6 2007	**46 anomalies**				
P1707126A.pos	Static-spike-static			Kingdon	Dalrymple
P1707126B.pos	Calibration lane		IMU drifting	Kingdon	Dalrymple
P1707126C.pos	Four corners			Kingdon	Dalrymple
P1707126D.pos	Slew test			Kingdon	Dalrymple
P1707126E.pos	Static			Kingdon	Dalrymple
P1707126F.pos	Cued-interrogation	SE1-36	Removed one spike in IMU	Kingdon	Dalrymple
P1707126G.pos	Cued-interrogation	SE1-41		Kingdon	Dalrymple
P1707126H.pos	Static		Two lines of static data	Kingdon	Dalrymple
P1707126I.pos	Cued-interrogation	SE1-34	RTS lost lock on first line	Kingdon	Dalrymple
P1707126J.pos	Cued-interrogation	SE1-31		Kingdon	Dalrymple
P1707126K.pos	Cued-interrogation	SE1-29	No RTS for one line, looks like it was fixed	Kingdon	Dalrymple
P1707126L.pos	Static			Kingdon	Dalrymple
P1707126M.pos	Cued-interrogation	SE1-22		Kingdon	Dalrymple
P1707126N.pos	Cued-interrogation	SE1-16		Kingdon	Dalrymple
P1707126O.pos	Cued-interrogation	SE1-13	Looks like a static and some RTS problems in first few lines	Kingdon	Dalrymple
P1707126P.pos	Cued-interrogation	SE1-8		Kingdon	Dalrymple
P1707126Q.pos	Static		Some IMU drift early, looks like it settles	Kingdon	Dalrymple
P1707126R.pos	Cued-interrogation	SE1-12	RTS lost on two lines: repeat	Kingdon	Dalrymple
P1707126S.pos	Cued-interrogation	SE1-2		Kingdon	Dalrymple

File	Type	Anomaly	Comment	Cart	Logger
P1707126T.pos	Static			Kingdon	Dalrymple
P1707126U.pos	Static			Kingdon	Dalrymple
P1707126V.pos	Cued-interrogation	SE2-64		Kingdon	Dalrymple
P1707126W.pos	Cued-interrogation	SE2-62		Kingdon	Dalrymple
P1707126X.pos	Static			Kingdon	Dalrymple
P1707126Y.pos	Cued-interrogation	SE2-59		Kingdon	Dalrymple
P1707126Z.pos	Cued-interrogation	SE2-56	Looks like largest signal on grid edge	Kingdon	Dalrymple
P1707126AA.pos	Cued-interrogation	SE2-54		Kingdon	Dalrymple
P1707126BB.pos	Static		Two lines, why the second line?	Kingdon	Dalrymple
P1707126CC.pos	Cued-interrogation	SE2-57		Kingdon	Dalrymple
P1707126DD.pos	Cued-interrogation	SE2-52		Kingdon	Dalrymple
P1707126EE.pos	Cued-interrogation	SE2-50		Kingdon	Dalrymple
P1707126FF.pos	Static			Kingdon	Dalrymple
P1707126GG.pos	Static		First line aborted	Kingdon	Dalrymple
P1707126HH.pos	Cued-interrogation	SE2-63	Manually joined with ii	Kingdon	Dalrymple
P1707126II.pos	Pitch line		Both pitch lines for last file (looks like DAS crashed)	Kingdon	Dalrymple
P1707126JJ.pos	Cued-interrogation	SE2-61	One spike in EM removed	Kingdon	Dalrymple
P1707126KK.pos	Cued-interrogation	SE2-58		Kingdon	Dalrymple
P1707126LL.pos	Static			Kingdon	Dalrymple
P1707126MM.pos	Cued-interrogation	SE2-60		Kingdon	Dalrymple
P1707126NN.pos	Cued-interrogation	SE2-53		Kingdon	Dalrymple
P1707126OO.pos	Cued-interrogation	SE2-55		Kingdon	Dalrymple
P1707126PP.pos	Static			Kingdon	Dalrymple
P1707126QQ.pos	Cued-interrogation	SE2-51		Kingdon	Dalrymple
P1707126RR.pos	Cued-interrogation	SE2-49		Kingdon	Dalrymple
P1707126SS.pos	Cued-interrogation	SE2-48	Missing last pitch line (manually joined with T event file)	Kingdon	Dalrymple
P1707126TT.pos	Pitch line		Last pitch line from previous file?	Kingdon	Dalrymple
P1707126UU.pos	Static		One EM spike removed	Kingdon	Dalrymple
P1707126VV.pos	Cued-interrogation	SE2-42	Possible static as first line	Kingdon	Dalrymple
P1707126WW.pos	Cued-interrogation	SE2-47		Kingdon	Dalrymple
P1707126XX.pos	Static		One EM-spike removed	Kingdon	Dalrymple
P1707126YY.pos	Static		IMU drifting	Kingdon	Dalrymple
P1707126ZZ.pos	Cued-interrogation	SE2-41		Kingdon	Dalrymple
P1707126AAA.pos	Cued-interrogation	SE2-45		Kingdon	Dalrymple
P1707126BBB.pos	Static		IMU drifting. One spike in EM	Kingdon	Dalrymple
P1707126CCC.pos	Cued-interrogation	SE2-43		Kingdon	Dalrymple
P1707126DDD.pos	Cued-interrogation	SE2-44		Kingdon	Dalrymple
P1707126EEE.pos	Cued-interrogation	SE2-46		Kingdon	Dalrymple
P1707126FFF.pos	Static		IMU drifing considerably	Kingdon	Dalrymple
P1707126GGG.pos	Cued-interrogation	SE2-40		Kingdon	Dalrymple
P1707126HHH.pos	Cued-interrogation	SE2-39		Dalrymple	Kingdon
P1707126III.pos	Cued-interrogation	SE2-38	Missing last pitch line (manually joined with JJJ event)	Dalrymple	Kingdon
P1707126JJJ.pos	Pitch line		Looks like pitch line for last file	Dalrymple	Kingdon
P1707126KKK.pos	Cued-interrogation	SE2-37		Dalrymple	Kingdon
P1707126LLL.pos	Static			Dalrymple	Kingdon
P1707126MMM.pos	Cued-interrogation	SE2-32		Dalrymple	Kingdon

File	Type	Anomaly	Comment	Cart	Logger
P1707126NNN.pos	Cued-interrogation	SE2-31		Dalrymple	Kingdon
P1707126OOO.pos	Cued-interrogation	SE2-28		Dalrymple	Kingdon
P1707126PPP.pos	Static			Dalrymple	Kingdon
P1707126QQQ.pos	Partial file?		No RTS	Dalrymple	Kingdon
P1707126RRR.pos	Cued-interrogation	SE2-23	Looks like RTS lost on 3rd last line	Dalrymple	Kingdon
P1707126SSS.pos	Cued-interrogation	SE2-22		Dalrymple	Kingdon
P1707126TTT.pos	Static			Dalrymple	Kingdon
P1707126UUU.pos	Cued-interrogation	SE2-14		Dalrymple	Kingdon
P1707126VVV.pos	Cued-interrogation	SE2-10	IMU drifting	Dalrymple	Kingdon
P1707126WWW.pos	Static		Two EM-spikes removed	Dalrymple	Kingdon
P1707126XXX.pos	Static-spike-static			Dalrymple	Kingdon
P1707126YYY.pos	Slew test		No RTS	Dalrymple	Kingdon
P1707126ZZZ.pos	Calibration lane			Dalrymple	Kingdon
			No limitations today		
May 7 2007			**31 anomalies but some DAS issues, so will have to recollect 12 of them.**		
P1707127A.pos	Static-spike-static			Dalrymple	Kingdon
P1707127B.pos	Calibration line			Dalrymple	Kingdon
P1707127C.pos	Four corners			Dalrymple	Kingdon
P1707127D.pos	Slew test			Dalrymple	Kingdon
P1707127E.pos	Static			Dalrymple	Kingdon
P1707127F.pos	Cued-interrogation	SE2-30		Dalrymple	Kingdon
P1707127G.pos	Cued-interrogation	SE2-26		Dalrymple	Kingdon
P1707127H.pos	Cued-interrogation	SE2-33		Dalrymple	Kingdon
P1707127I.pos	Static		Remove first line	Dalrymple	Kingdon
P1707127J.pos	Cued-interrogation	SE2-25		Dalrymple	Kingdon
P1707127K.pos	Cued-interrogation	SE2-27		Dalrymple	Kingdon
P1707127L.pos	Cued-interrogation	SE2-24		Dalrymple	Kingdon
P1707127M.pos	Static			Dalrymple	Kingdon
P1707127N.pos	Cued-interrogation	SE2-34		Dalrymple	Kingdon
P1707127O.pos	Cued-interrogation	SE2-35	Spike removed from IMU	Dalrymple	Kingdon
P1707127P.pos	Cued-interrogation	SE2-36		Dalrymple	Kingdon
P1707127Q.pos	Static			Dalrymple	Kingdon
P1707127R.pos	Cued-interrogation	SE2-20	Spike removed from IMU	Dalrymple	Kingdon
P1707127S.pos	Cued-interrogation	SE2-21		Dalrymple	Kingdon
P1707127T.pos	Cued-interrogation	SE2-19		Dalrymple	Kingdon
P1707127U.pos	Static			Kingdon	Dalrymple
P1707127V.pos	Cued-interrogation	SE2-18	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed. IMU unreliable. Static as first line. Manually split into events V to DD.	Kingdon	Dalrymple
P1707127W.pos	Static		Manually delete first line	Kingdon	Dalrymple
P1707127X.pos	Cued-interrogation	SE2-17	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed	Kingdon	Dalrymple

File	Type	Anomaly	Comment	Cart	Logger
P1707127Y.pos	Cued-interrogation	SE2-15	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed	Kingdon	Dalrymple
P1707127Z.pos	Static			Kingdon	Dalrymple
P1707127AA.pos	Cued-interrogation	SE2-16	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed	Kingdon	Dalrymple
P1707127BB.pos	Cued-interrogation	SE2-13	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed	Kingdon	Dalrymple
P1707127CC.pos	Cued-interrogation	SE2-9	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed	Kingdon	Dalrymple
P1707127DD.pos	Cued-interrogation	SE2-7	DAS issue and multiple events recorded in one file. Had to remove all data past 08:42, time-stamps are unreliable. One IMU spike removed	Kingdon	Dalrymple
			DAS failure, so had to recollect many items		
May 8 2007			**38 anomalies on the GPO**		
P1707128A.pos	Static-spike-static			Dalrymple	Kingdon
P1707128B.pos	Calibration Line			Dalrymple	Kingdon
P1707128C.pos	Four corners			Dalrymple	Kingdon
P1707128D.pos	Slew test			Dalrymple	Kingdon
P1707128E.pos	Static			Dalrymple	Kingdon
P1707128F.pos	Cued-interrogation	GPO-01	Weak anomaly	Dalrymple	Kingdon
P1707128G.pos	Cued-interrogation	GPO-02	IMU acting up potentially.	Dalrymple	Kingdon
P1707128H.pos	Cued-interrogation	GPO-06	Weak anomaly	Dalrymple	Kingdon
P1707128I.pos	Cued-interrogation	GPO-08		Dalrymple	Kingdon
P1707128J.pos	Static			Dalrymple	Kingdon
P1707128K.pos	Cued-interrogation	GPO-03		Dalrymple	Kingdon
P1707128L.pos	Cued-interrogation	GPO-11		Dalrymple	Kingdon
P1707128M.pos	Static			Dalrymple	Kingdon
P1707128N.pos	Cued-interrogation	GPO-09	Very weak anomaly	Dalrymple	Kingdon
P1707128O.pos	Cued-interrogation	GPO-04	Very weak anomaly	Dalrymple	Kingdon
P1707128P.pos	Cued-interrogation	GPO-12		Dalrymple	Kingdon
P1707128Q.pos	Static			Dalrymple	Kingdon
P1707128R.pos	Cued-interrogation	GPO-05		Dalrymple	Kingdon
P1707128S.pos	Cued-interrogation	GPO-16	Weak anomaly	Dalrymple	Kingdon
P1707128T.pos	Cued-interrogation	GPO-17		Dalrymple	Kingdon
P1707128U.pos	Static			Dalrymple	Kingdon
P1707128V.pos	Static			Kingdon	Dalrymple
P1707128W.pos	Cued-interrogation	GPO-18		Kingdon	Dalrymple
P1707128X.pos	Cued-interrogation	GPO-15		Kingdon	Dalrymple
P1707128Y.pos	Cued-interrogation	GPO-25		Kingdon	Dalrymple
P1707128Z.pos	Static			Kingdon	Dalrymple
P1707128AA.pos	Cued-interrogation	GPO-14		Kingdon	Dalrymple
P1707128BB.pos	Cued-interrogation	GPO-26		Kingdon	Dalrymple
P1707128CC.pos	Partial		RTS looks corrupted … DAS crash?	Kingdon	Dalrymple
P1707128DD.pos	Cued-interrogation	GPO-13		Kingdon	Dalrymple

File	Type	Anomaly	Comment	Cart	Logger
P1707128EE.pos	Static			Kingdon	Dalrymple
P1707128FF.pos	Cued-interrogation	GPO-28		Kingdon	Dalrymple
P1707128GG.pos	Cued-interrogation	GPO-30		Kingdon	Dalrymple
P1707128HH.pos	Static			Kingdon	Dalrymple
P1707128II.pos	Static			Kingdon	Dalrymple
P1707128JJ.pos	Cued-interrogation	GPO-10		Kingdon	Dalrymple
P1707128KK.pos	Cued-interrogation	GPO-07		Kingdon	Dalrymple
P1707128LL.pos	Cued-interrogation	GPO-31		Kingdon	Dalrymple
P1707128MM.pos	Static			Kingdon	Dalrymple
P1707128NN.pos	Static			Dalrymple	Kingdon
P1707128OO.pos	Cued-interrogation	GPO-32		Dalrymple	Kingdon
P1707128PP.pos	Cued-interrogation	GPO-34		Dalrymple	Kingdon
P1707128QQ.pos	Cued-interrogation	GPO-33		Dalrymple	Kingdon
P1707128RR.pos	Static			Dalrymple	Kingdon
P1707128SS.pos	Static		IMU drifting	Dalrymple	Kingdon
P1707128TT.pos	Cued-interrogation		IMU acting up	Dalrymple	Kingdon
P1707128UU.pos	Cued-interrogation	GPO-35	large rut through gpo35	Dalrymple	Kingdon
P1707128VV.pos	Cued-interrogation	GPO-29	One spike removed from EM	Dalrymple	Kingdon
P1707128WW.pos	Static			Dalrymple	Kingdon
P1707128XX.pos	Cued-interrogation	GPO-36	Speculation this is correct (no label)	Dalrymple	Kingdon
P1707128YY.pos	Cued-interrogation	GPO-27	One spike removed from EM	Dalrymple	Kingdon
P1707128ZZ.pos	Cued-interrogation	GPO-23		Dalrymple	Kingdon
P1707128AAA.pos	Partial	GPO-37		Dalrymple	Kingdon
P1707128BBB.pos	Cued-interrogation	GPO-37		Dalrymple	Kingdon
P1707128CCC.pos	Cued-interrogation	GPO-24	Missing RTS	Dalrymple	Kingdon
P1707128DDD.pos	Static			Dalrymple	Kingdon
P1707128EEE.pos	Static			Kingdon	Dalrymple
P1707128FFF.pos	Cued-interrogation	GPO-19		Kingdon	Dalrymple
P1707128GGG.pos	Cued-interrogation	GPO-20		Kingdon	Dalrymple
P1707128HHH.pos	Cued-interrogation	GPO-22		Kingdon	Dalrymple
P1707128III.pos	Static			Kingdon	Dalrymple
P1707128JJJ.pos	Cued-interrogation	GPO-21		Kingdon	Dalrymple
P1707128KKK.pos	Cued-interrogation	GPO-38		Kingdon	Dalrymple
P1707128LLL.pos	Static			Kingdon	Dalrymple
P1707128MMM.pos	Static		Check	Kingdon	Dalrymple
P1707128NNN.pos	Cued-interrogation	SW-08		Kingdon	Dalrymple
P1707128OOO.pos	Static			Kingdon	Dalrymple
P1707128PPP.pos	Static			Kingdon	Dalrymple
P1707128QQQ.pos	Static			Kingdon	Dalrymple
P1707128RRR.pos	Partial			Kingdon	Dalrymple
P1707128SSS.pos	Cued-interrogation	SW-01		Kingdon	Dalrymple
P1707128TTT.pos	Static			Kingdon	Dalrymple
P1707128UUU.pos	Static			Kingdon	Dalrymple
P1707128VVV.pos	Cued-interrogation	SW-61		Kingdon	Dalrymple
P1707128WWW.pos	Static			Kingdon	Dalrymple
P1707128XXX.pos	Static-spike-static			Kingdon	Dalrymple

File	Type	Anomaly	Comment	Cart	Logger
P1707128YYY.pos	Slew test		No RTS data	Kingdon	Dalrymple
P1707128ZZZ.pos	Calibration Line			Kingdon	Dalrymple
			No limitations		
May 9 2007			**Remaining 12 anomalies plus a number of transects**		
P1707129A.pos	Spike-static-spike			Dalrymple	Kingdon
P1707129B.pos	Slew test		No RTS	Dalrymple	Kingdon
P1707129C.pos	Calibration Line			Dalrymple	Kingdon
P1707129D.pos	Four corners			Dalrymple	Kingdon
P1707129E.pos	Static			Dalrymple	Kingdon
P1707129F.pos	Cued-interrogation	SE2-1		Dalrymple	Kingdon
P1707129G.pos	Cued-interrogation	SE2-5		Dalrymple	Kingdon
P1707129H.pos	Static			Dalrymple	Kingdon
P1707129I.pos	Static			Dalrymple	Kingdon
P1707129J.pos	Cued-interrogation	SE2-2		Dalrymple	Kingdon
P1707129K.pos	Cued-interrogation	SE2-4		Dalrymple	Kingdon
P1707129L.pos	Static			Dalrymple	Kingdon
P1707129M.pos	Cued-interrogation	SE2-3	Last pitch line looks suspicious	Dalrymple	Kingdon
P1707129N.pos	Cued-interrogation	SE2-8		Dalrymple	Kingdon
P1707129O.pos	Static			Dalrymple	Kingdon
P1707129P.pos	Cued-interrogation	SE2-29		Dalrymple	Kingdon
P1707129Q.pos	Partial		Two lines	Dalrymple	Kingdon
P1707129R.pos	Cued-interrogation	SE2-11		Dalrymple	Kingdon
P1707129S.pos	Static			Dalrymple	Kingdon
P1707129T.pos	Cued-interrogation	SE2-6	Spike removed from IMU	Dalrymple	Kingdon
P1707129U.pos	Cued-interrogation	SE2-12		Dalrymple	Kingdon
P1707129V.pos	Cued-interrogation	SE2-10		Dalrymple	Kingdon
P1707129W.pos	Static			Dalrymple	Kingdon
P1707129X.pos	Static			Dalrymple	Kingdon
P1707129Y.pos	Cued-interrogation	SE1-12		Dalrymple	Kingdon
P1707129Z.pos	Static			Dalrymple	Kingdon
P1707129AA.pos	Static			Kingdon	Dalrymple
P1707129BB.pos	Corrupted data			Kingdon	Dalrymple
P1707129CC.pos	Static		Too short	Kingdon	Dalrymple
P1707129DD.pos	Static		IMU drifting	Kingdon	Dalrymple
P1707129EE.pos	Transect		IMU data on first line looks suspiccious	Kingdon	Dalrymple
P1707129FF.pos	Static			Kingdon	Dalrymple
P1707129GG.pos	Transect		One spike in IMU: not removed	Kingdon	Dalrymple
P1707129HH.pos	Static		IMU drifting	Kingdon	Dalrymple
P1707129II.pos	Static-spike-static		IMU looks noisy	Kingdon	Dalrymple
P1707129JJ.pos	Slew test		No RTS	Kingdon	Dalrymple
P1707129KK.pos	Calibration Line			Kingdon	Dalrymple
			No limitations		
May 10 2007			**100% coverage of GPO plus a number of transects**		
P1707130A.pos	Static-spike-static			Kingdon	Dalrymple
P1707130B.pos	Slew-test		No RTS	Kingdon	Dalrymple
P1707130C.pos	Calibration Lane			Kingdon	Dalrymple

File	Type	Anomaly	Comment	Cart	Logger
P1707130D.pos	Four corners			Kingdon	Dalrymple
P1707130E.pos	Static			Kingdon	Dalrymple
P1707130F.pos	Transect			Kingdon	Dalrymple
P1707130G.pos	Static		Very short … a few seconds	Kingdon	Dalrymple
P1707130H.pos	Static			Kingdon	Dalrymple
P1707130I.pos	Transect			Kingdon	Dalrymple
P1707130J.pos	Static			Kingdon	Dalrymple
P1707130K.pos	Static			Kingdon	Dalrymple
P1707130L.pos	Transect		One IMU spike removed	Kingdon	Dalrymple
P1707130M.pos	Static			Kingdon	Dalrymple
P1707130N.pos	Transect			Kingdon	Dalrymple
P1707130O.pos	Static			Kingdon	Dalrymple
P1707130P.pos	Empty file		Just a second or two of data	Kingdon	Dalrymple
P1707130Q.pos	Static			Kingdon	Dalrymple
P1707130R.pos	Transect		One IMU spike removed	Kingdon	Dalrymple
P1707130S.pos	Static			Kingdon	Dalrymple
P1707130T.pos	Static			Kingdon	Dalrymple
P1707130U.pos	Transect			Kingdon	Dalrymple
P1707130V.pos	Static			Kingdon	Dalrymple
P1707130W.pos	Transect		One IMU spike removed	Kingdon	Dalrymple
P1707130X.pos	Static			Kingdon	Dalrymple
P1707130Y.pos	Transect			Dalrymple	Kingdon
P1707130Z.pos	Static			Dalrymple	Kingdon
P1707130AA.pos	Transect			Dalrymple	Kingdon
P1707130BB.pos	Static		Some IMU drift	Dalrymple	Kingdon
P1707130CC.pos	Transect		Interesting drift in the EM … soils?	Dalrymple	Kingdon
P1707130DD.pos	Static			Dalrymple	Kingdon
P1707130EE.pos	Static		No RTS or EM data	Dalrymple	Kingdon
P1707130FF.pos	Static			Dalrymple	Kingdon
P1707130GG.pos	Transect			Dalrymple	Kingdon
P1707130HH.pos	Static			Dalrymple	Kingdon
P1707130II.pos	Transect		Interesting IMU … probably OK, but suspicuous	Dalrymple	Kingdon
P1707130JJ.pos	Static			Dalrymple	Kingdon
P1707130KK.pos	Static			Dalrymple	Kingdon
P1707130LL.pos	Transect			Dalrymple	Kingdon
P1707130MM.pos	Static		Not many points	Dalrymple	Kingdon
P1707130NN.pos	Static			Dalrymple	Kingdon
P1707130OO.pos	Transect			Dalrymple	Kingdon
P1707130PP.pos	Static			Dalrymple	Kingdon
P1707130QQ.pos	Transect			Dalrymple	Kingdon
P1707130RR.pos	Static			Dalrymple	Kingdon
P1707130SS.pos	Start of static-spike?			Dalrymple	Kingdon
P1707130TT.pos	Completion of static-spike?			Dalrymple	Kingdon
P1707130UU.pos	Slew-test		No RTS	Dalrymple	Kingdon
P1707130VV.pos	Calibration Lane			Dalrymple	Kingdon

File	Type	Anomaly	Comment	Cart	Logger
			No limitations		
May 11 2007			**Do 2 repeats on GPO and 100% coverage of area to east of GPO**		
P1707131A.pos	Static-spike-static			Dalrymple	Kingdon
P1707131B.pos	Slew-test		No RTS	Dalrymple	Kingdon
P1707131C.pos	Calibration Lane			Dalrymple	Kingdon
P1707131D.pos	Four corners			Dalrymple	Kingdon
P1707131E.pos	Static			Dalrymple	Kingdon
P1707131F.pos	Cued-interrogation	GPO-24		Dalrymple	Kingdon
P1707131G.pos	Static			Dalrymple	Kingdon
P1707131H.pos	Cued-interrogation	GPO-02		Dalrymple	Kingdon
P1707131I.pos	Static			Dalrymple	Kingdon
P1707131J.pos	Static			Dalrymple	Kingdon
P1707131K.pos	Transect			Dalrymple	Kingdon
P1707131L.pos	Static			Dalrymple	Kingdon
P1707131M.pos	Transect		One spike in IMU removed	Dalrymple	Kingdon
P1707131N.pos	Static			Dalrymple	Kingdon
P1707131O.pos	Transect			Dalrymple	Kingdon
P1707131P.pos	Static		IMU drifting	Dalrymple	Kingdon
P1707131Q.pos	Static			Kingdon	Dalrymple
P1707131R.pos	Transect			Kingdon	Dalrymple
P1707131S.pos	Static			Kingdon	Dalrymple
P1707131T.pos	Transect			Kingdon	Dalrymple
P1707131U.pos	Static		Ignore first line	Kingdon	Dalrymple
P1707131V.pos	Transect			Kingdon	Dalrymple
P1707131W.pos	Static			Kingdon	Dalrymple
P1707131X.pos	Static-spike-static			Kingdon	Dalrymple
P1707131Y.pos	Slew-test		No RTS	Kingdon	Dalrymple
P1707131Z.pos	Calibration Lane			Kingdon	Dalrymple

APPENDIX E: DATA PROCESSING AND QC TRACKING LOG

In this appendix we list each cued-interrogation anomaly and identify the corresponding survey event (or events) file. The analysts processing notes are also recorded. There was one anomaly with unstable IMU data (SE2-18) that is identified in red. Several anomalies with one or more lines of data missing are identified in pale-yellow.

ID	Easting	Northing	Event	Second event	Comments
South-East 1 Cued Interrogation					
SE1-01	578923.08	3751639.8	P1707125Z.pos		Many top-coil spikes removed
SE1-02	578868.89	3751645.1	P1707126S.pos		Multiple spikes removed from top-coil
SE1-03	578929.7	3751645.1	P1707125W.pos		OK
SE1-04	578883.71	3751652.1	P1707125DD.pos		Multiple spikes removed from top-coil
SE1-05	578891.98	3751652.9	P1707125CC.pos		Multiple spikes removed from top-coil
SE1-06	578906.7	3751655.4	P1707125V.pos		Missing half of EW center line - 2 spikes removed from bottom coil
SE1-07	578881.52	3751656.3	P1707125EE.pos		Multiple spikes removed from top-coil
SE1-08	578837.67	3751661.4	P1707126P.pos		Multiple spikes removed from top-coil
SE1-09	578947.94	3751662.7	P1707125K.pos		One backtrack deleted,multiple top-coil spikes removed
SE1-10	578880.41	3751663.6	P1707125HH.pos		Delete one short line, multiple top-coil spikes removed
SE1-11	578914.08	3751663.4	P1707125T.pos		One bottom coil spike removed
SE1-12	578861.34	3751664.8	P1707129Y.pos		Multiple spikes removed from top-coil
SE1-13	578841.07	3751665.5	P1707126O.pos		OK
SE1-14	578939.36	3751666	P1707125L.pos		One bottom coil spike removed
SE1-15	578924.48	3751666.8	P1707125S.pos		Multiple spikes removed from bottom coil
SE1-16	578823.3	3751669.5	P1707126N.pos		Two redundant lines deleted
SE1-17	578971.65	3751669.5	P1707124RR.pos		OK
SE1-18	578944.9	3751673.2	P1707124XX.pos		Multiple spikes removed from top-coil
SE1-19	578878.16	3751677.5	P1707125II.pos		Multiple spikes removed from top-coil
SE1-20	578960.74	3751677.7	P1707124UU.pos		Multiple spikes removed from top-coil
SE1-21	578968.54	3751678	P1707124SS.pos		Multiple spikes removed from top-coil
SE1-22	578854.8	3751679.3	P1707126M.pos		Multiple spikes removed from top-coil
SE1-23	578980.23	3751680.6	P1707124PP.pos		One short line deleted, one top-coil spike removed
SE1-24	579042.98	3751681.9	P1707124MM.pos		Multiple spikes removed from top-coil
SE1-25	578912.58	3751683.1	P1707125Q.pos		OK
SE1-26	579032.38	3751683	P1707124LL.pos		Multiple spikes removed from top-coil
SE1-27	578879.97	3751684.6	P1707125JJ.pos		One top-coil spike removed
SE1-28	578930.45	3751685.6	P1707125M.pos		Multiple spikes removed from bottom coil
SE1-29	578856.24	3751686.8	P1707126K.pos		Multiple spikes removed from top-coil
SE1-30	578947.36	3751686.9	P1707124YY.pos		One short line deleted. Multiple spikes removed from top-coil
SE1-31	578852.19	3751687.2	P1707126J.pos		Multiple spikes removed from top-coil
SE1-32	579027.59	3751688.1	P1707124KK.pos		Multiple spikes removed from top-coil
SE1-33	578992.57	3751690.9	P1707124II.pos		Multiple spikes removed from top-coil
SE1-34	578851.58	3751693.8	P1707126I.pos		Multiple spikes removed from top-coil

ID	Easting	Northing	Event	Second event	Comments
SE1-35	578946.2	3751694.2	P1707124AAA.pos		Multiple spikes removed from top-coil
SE1-36	578814.43	3751695.8	P1707126F.pos		Multiple spikes removed from top-coil
SE1-37	578937.76	3751695.9	P1707125O.pos		OK
SE1-38	578936.17	3751697.5	P1707125P.pos		One bottom coil spike removed
SE1-39	578953.89	3751702.7	P1707124ZZ.pos		Multiple spikes removed from top-coil
SE1-40	578982.6	3751704.3	P1707124HH.pos		One short line deleted. Multiple spikes removed from top-coil
SE1-41	578820.33	3751706.3	P1707126G.pos		Multiple spikes removed from top-coil
SE1-42	578892.79	3751705.9	P1707125LL.pos		Multiple spikes removed from top-coil
SE1-43	578996.81	3751710	P1707124DD.pos		OK
SE1-44	578995.11	3751713.7	P1707124CC.pos		OK
SE1-45	579010.51	3751714.6	P1707125G.pos		OK
SE1-46	579013.95	3751714.3	P1707125H.pos		OK
SE1-47	578915.1	3751719.8	P1707125QQ.pos		Multiple spikes removed from top-coil
SE1-48	578880.28	3751720.3	P1707125MM.pos		Multiple spikes removed from top-coil
SE1-49	578919.06	3751719.8	P1707125PP.pos		One backtrack deleted,multiple top-coil spikes removed
SE1-50	578998.78	3751719.8	P1707124BB.pos		One short-line deleted
SE1-51	578943.47	3751721.8	P1707124M.pos		One short-line deleted
SE1-52	578907.46	3751726.1	P1707125SS.pos		Multiple spikes removed from top-coil
SE1-53	578970.24	3751726.5	P1707124Z.pos		OK
SE1-54	578906.49	3751728.4	P1707125TT.pos		Multiple spikes removed from top-coil
SE1-55	578900.76	3751729.2	P1707125UU.pos		Multiple spikes removed from top-coil
SE1-56	578929.26	3751730.2	P1707124I.pos		One spike removed from top-coil
SE1-57	578937.46	3751732.3	P1707124F.pos		Multiple spikes removed from top-coil
SE1-58	578886.77	3751733.2	P1707125NN.pos		Multiple spikes removed from top-coil
SE1-59	578945.03	3751734.3	P1707124E.pos		Multiple spikes removed from top-coil
SE1-60	578938.41	3751735	P1707124D.pos		Multiple spikes removed from top-coil
SE1-61	578929.75	3751735.8	P1707124J.pos		Removed two spurious lines
SE1-62	578971.65	3751737.7	P1707124Q.pos		One backtrack removed
SE1-63	578996	3751739.3	P1707124Y.pos		One bottom coil spike removed
SE1-64	578918.93	3751743	P1707124K.pos		One top-coil spike removed
SE1-65	578977.16	3751759.9	P1707124S.pos		One short line removed, One top-coil spike removed
SE1-66	578985.04	3751760.6	P1707124T.pos		Multiple spikes removed from top-coil
SE1-67	578995.26	3751766.8	P1707124X.pos		OK
SE1-68	579000.11	3751771.2	P1707124W.pos		One bottom coil spike removed
South-East 2 Cued Interrogation					
SE2-01	579035.29	3751517.9	P1707129F.pos		Multiple spikes removed from top-coil
SE2-02	579057.61	3751518.1	P1707129J.pos		Multiple spikes removed from top-coil
SE2-03	579069.57	3751517.9	P1707129M.pos		One short line removed. Multiple spikes removed from top-coil
SE2-04	579057.01	3751522.5	P1707129K.pos		Multiple spikes removed from top-coil
SE2-05	579031.12	3751526.6	P1707129G.pos		OK
SE2-06	579034.04	3751529.8	P1707129T.pos		Multiple spikes removed from top-coil
SE2-07	579061.41	3751530	P1707127DD.pos		One short line removed. Multiple spikes removed from top-coil
SE2-08	579045.09	3751531.1	P1707129N.pos		Multiple spikes removed from top-coil

ID	Easting	Northing	Event	Second event	Comments
SE2-09	579060.74	3751535.2	P1707127CC.pos		Multiple spikes removed from top-coil
SE2-10	579029.53	3751536.6	P1707129V.pos		One top-coil spike removed
SE2-11	579040.58	3751538.6	P1707129R.pos		Multiple spikes removed from top-coil
SE2-12	579033.67	3751541	P1707129U.pos		Multiple spikes removed from top-coil
SE2-13	579056.55	3751540.7	P1707127BB.pos		One short line removed. Multiple spikes removed from top-coil
SE2-14	579023.59	3751542.2	P1707126UUU.pos		Multiple spikes removed from top-coil
SE2-15	579062.79	3751542.5	P1707127Y.pos		Multiple spikes removed from top-coil
SE2-16	579058.84	3751543.4	P1707127AA.pos		Multiple spikes removed from top-coil
SE2-17	579052.04	3751544.7	P1707127X.pos		Multi-object scenario. Multiple spikes removed from top-coil
SE2-18	579057.74	3751545.8	P1707127V.pos		IMU data no good. Two lines removed (one of them a erroneous pitch line). Multiple spikes removed from top-coil
SE2-19	579051.29	3751548.5	P1707127T.pos		Multiple spikes removed from top-coil
SE2-20	579069.61	3751549.9	P1707127R.pos		Multiple spikes removed from top-coil
SE2-21	579056.34	3751550.9	P1707127S.pos		Multiple spikes removed from top-coil
SE2-22	579013.22	3751553	P1707126SSS.pos		One top-coil spike removed
SE2-23	579007.68	3751555.4	P1707126RRR.pos		One redundant line removed. Multiple spikes removed from top-coil
SE2-24	579044.64	3751555.6	P1707127L.pos		Multiple spikes removed from top-coil
SE2-25	579039.02	3751556.6	P1707127J.pos		Multiple spikes removed from top-coil
SE2-26	579055.2	3751557.5	P1707127G.pos		One short line removed. Multiple spikes removed from top-coil
SE2-27	579033.74	3751559	P1707127K.pos		Multiple spikes removed from top-coil
SE2-28	579010.53	3751559.6	P1707126OOO.pos		Multiple spikes removed from top-coil
SE2-29	579067.18	3751559.8	P1707129P.pos		Multiple spikes removed from top-coil
SE2-30	579055.93	3751560.1	P1707127F.pos		Multiple spikes removed from top-coil
SE2-31	579018.62	3751563.6	P1707126NNN.pos		Multiple spikes removed from top-coil
SE2-32	579029.03	3751563.9	P1707126MMM.pos		Multiple spikes removed from top-coil
SE2-33	579037.63	3751563.7	P1707127H.pos		Multiple spikes removed from top-coil
SE2-34	579048.29	3751565.3	P1707127N.pos		One spike removed from top-coil
SE2-35	579046.03	3751566.3	P1707127O.pos		Multiple spikes removed from top-coil
SE2-36	579041.98	3751566.5	P1707127P.pos		Multiple spikes removed from top-coil
SE2-37	579029.04	3751568.7	P1707126KKK.pos		Multiple spikes removed from top-coil
SE2-38	579035.85	3751570.4	P1707126III.pos		Multiple spikes removed from top-coil
SE2-39	579032.09	3751574.8	P1707126HHH.pos		Multiple spikes removed from top-coil
SE2-40	579007.79	3751577.2	P1707126GGG.pos		Multiple spikes removed from top-coil
SE2-41	579024.29	3751579.6	P1707126ZZ.pos		One short line removed. Multiple spikes removed from top-coil
SE2-42	579037.08	3751586.1	P1707126VV.pos		One short line removed. Multiple spikes removed from top-coil
SE2-43	579009.88	3751586.9	P1707126CCC.pos		Multiple spikes removed from top-coil
SE2-44	579007.11	3751587.5	P1707126DDD.pos		Multiple spikes removed from top-coil
SE2-45	579020.45	3751587.6	P1707126AAA.pos		Multiple spikes removed from top-coil
SE2-46	579009.59	3751589.1	P1707126EEE.pos		Multiple spikes removed from top-coil
SE2-47	579044.71	3751593.5	P1707126WW.pos		Multiple spikes removed from top-coil
SE2-48	579024.8	3751594.2	P1707126SS.pos		1 spike in channel 5

ID	Easting	Northing	Event	Second event	Comments
SE2-49	579018.97	3751598.8	P1707126RR.pos		OK
SE2-50	579045.11	3751601.4	P1707126EE.pos		2 spikes in channel 5
SE2-51	579010.69	3751605.8	P1707126QQ.pos		One spike removed from top-coil. 2 spikes in channel 5
SE2-52	579033.11	3751606.6	P1707126DD.pos		1 spike in channel 5
SE2-53	579016.05	3751610.4	P1707126NN.pos		OK
SE2-54	579039.34	3751610.6	P1707126AA.pos		OK
SE2-55	579011.72	3751611.3	P1707126OO.pos		One bottom coil spike removed
SE2-56	579042.6	3751612.1	P1707126Z.pos		OK
SE2-57	579031.97	3751613	P1707126CC.pos		1 spike in channel 5
SE2-58	579016.96	3751613.4	P1707126KK.pos		Two bottom coil spikes removed, 1 spike in channel 5
SE2-59	579043.86	3751614.2	P1707126Y.pos		4 spikes in channel 5
SE2-60	579021.13	3751615.8	P1707126MM.pos		2 spikes in channel 5
SE2-61	579021.59	3751619.1	P1707126JJ.pos		2 spikes in channel 5
SE2-62	579038.56	3751619.9	P1707126W.pos		1 spike in channel 5
SE2-63	579010.86	3751624.3	P1707126HH.pos		1 spike in channel 5
SE2-64	579046	3751629.8	P1707126V.pos		3 spikes in channel 5
South-West Cued Interrogation					
SW-01	578500.29	3751350	P1707128SSS.pos		OK, multiple top-coil spikes removed
SW-02	578372.94	3751352.4	P1707123U.pos		OK, multiple top-coil spikes removed
SW-03	578395.08	3751354.2	P1707123S.pos		One spike manually deleted
SW-04	578274.74	3751356.7	P1707121BB.pos		RTS set-up problem fixed; Multiple bottom coil spikes removed. One short line deleted
SW-05	578357.25	3751358.9	P1707123V.pos		OK, multiple top-coil spikes removed
SW-06	578406.02	3751359.3	P1707123R.pos		OK, multiple top-coil spikes removed
SW-07	578283.71	3751360.9	P1707121DD.pos		RTS set-up problem fixed; Multiple bottom coil spikes removed.
SW-08	578380.52	3751364	P1707128NNN.pos		OK, multiple top-coil spikes removed
SW-09	578257	3751368.2	P1707121Y.pos		RTS set-up problem fixed; Multiple top coil spikes removed.
SW-10	578445.14	3751369.5	P1707123Z.pos		OK, multiple top-coil spikes removed
SW-11	578464.3	3751369.3	P1707123AA.pos		OK, multiple top-coil spikes removed
SW-12	578475.18	3751369.6	P1707123CC.pos		Pitch lines are poor. Multiple top-coil spikes removed
SW-13	578285.1	3751374.1	P1707121FF.pos		RTS set-up problem fixed; One bottom coil spike removed. One short line deleted
SW-14	578466.4	3751375.5	P1707123DD.pos		OK, multiple top-coil spikes removed
SW-15	578300.18	3751377.7	P1707122L.pos	P1707121HH.pos	RTS setup problem fixed. One short line deleted
SW-16	578311.93	3751378.8	P1707122H.pos		RTS set-up problem fixed
SW-17	578304.11	3751380.9	P1707121MM.pos		RTS set-up problem fixed; Multiple top coil spikes removed.
SW-18	578408.86	3751382.2	P1707123P.pos		Remove one backtrack, multiple top-coil spikes removed
SW-19	578471.68	3751385.4	P1707123EE.pos		OK, multiple top-coil spikes removed
SW-20	578297.32	3751388.2	P1707122Q.pos		RTS set-up problem fixed

ID	Easting	Northing	Event	Second event	Comments
SW-21	578476.7	3751389	P1707123GG.pos		OK, delete a number of spikes in lower and upper coils. Remove one extra line of data
SW-22	578287.25	3751389.8	P1707121KK.pos		RTS set-up problem fixed; Multiple top coil spikes removed.
SW-23	578366.59	3751394.3	P1707122YY.pos		RTS set-up problem fixed. Missing one line
SW-24	578377.56	3751396	P1707122AAA.pos		RTS set-up problem fixed. Removed one bottom coil spike
SW-25	578281.62	3751396.7	P1707122F.pos		RTS set-up problem fixed
SW-26	578428.34	3751401	P1707123N.pos		OK, delete multiple spikes in top-coil
SW-27	578440.57	3751407.4	P1707123L.pos		OK, delete multiple spikes in top-coil
SW-28	578378.37	3751410.1	P1707122XX.pos		RTS set-up problem fixed.One backtrack deleted
SW-29	578432.11	3751415.7	P1707123K.pos		OK deleted one top-coil spike
SW-30	578456.94	3751415.9	P1707123H.pos		OK, delete multiple spikes in top-coil
SW-31	578435.22	3751416.7	P1707123G.pos		OK, delete multiple spikes in top-coil
SW-32	578325.03	3751418.6	P1707122HH.pos		RTS set-up problem fixed
SW-33	578282.67	3751427.2	P1707122J.pos		RTS set-up problem fixed. Several lines deleted
SW-34	578274.96	3751429	P1707122N.pos	P1707122O.pos	RTS set-up problem fixed. One backtrack deleted. One line missing some data. Had to join file N and O together
SW-35	578330.2	3751429.1	P1707122FF.pos		RTS set-up problem fixed. One line deleted
SW-36	578318.84	3751431.5	P1707122W.pos	P1707122X.pos	RTS set-up problem fixed: DAS crash … time reset partway through file. Needed to run process_all on X and W separately and manually join together due to DAS clock getting reset. Delete two extra lines
SW-37	578420.75	3751432.1	P1707122CCC.pos		OK
SW-38	578492.78	3751436.8	P1707123II.pos		OK
SW-39	578430.96	3751444.5	P1707122EEE.pos		RTS set-up problem fixed
SW-40	578373.06	3751446.3	P1707122MM.pos		RTS set-up problem fixed
SW-41	578315.9	3751447.5	P1707122Z.pos		RTS setup problem fixed. One short line deleted
SW-42	578459.95	3751447.8	P1707123UU.pos		Delete on spurious line
SW-43	578453.88	3751453.2	P1707123SS.pos		OK
SW-44	578479.37	3751455.1	P1707123JJ.pos		OK deleted one top-coil spike
SW-45	578454.45	3751458.1	P1707123RR.pos		OK, deleted one spike
SW-46	578452.02	3751461.2	P1707123QQ.pos		OK, one backtrack deleted
SW-47	578304.95	3751463.6	P1707122BB.pos		RTS setup problem fixed. One short line deleted
SW-48	578269.36	3751463.9	P1707122S.pos		RTS set-up problem fixed.One backtrack deleted
SW-49	578434.79	3751465.3	P1707123WW.pos		OK
SW-50	578461.43	3751467	P1707123OO.pos		One spike manually deleted
SW-51	578470.06	3751467.6	P1707123NN.pos		OK, one backtrack deleted
SW-52	578427.37	3751475	P1707123ZZ.pos		OK, anomaly offset from center
SW-53	578309.15	3751477.9	P1707122DD.pos		RTS set-up problem fixed.One bottom-coil spike removed
SW-54	578428.6	3751478.5	P1707123AAA.pos		OK
SW-55	578449.49	3751478.4	P1707123XX.pos		OK
SW-56	578418.57	3751482	P1707123EEE.pos		One short line deleted, anomaly offset from center

ID	Easting	Northing	Event	Second event	Comments
SW-57	578379.45	3751484.3	P1707122PP.pos		RTS set-up problem fixed
SW-58	578384.11	3751485	P1707122SS.pos		RTS set-up problem fixed. One partial line
SW-59	578429.02	3751486.6	P1707123FFF.pos		Short line deleted
SW-60	578362.61	3751490	P1707122KK.pos		RTS set-up problem fixed. No pitch lines
SW-61	578487.11	3751490.6	P1707128VVV.pos		OK, delete multiple spikes in top-coil
SW-62	578463.31	3751490.3	P1707123MMM.pos		OK, delete multiple spikes in top-coil
SW-63	578440.37	3751490.8	P1707123JJJ.pos		Multiple anomalies, several top-coil spikes removed, one backtrack removed
SW-64	578391.62	3751492.4	P1707122VV.pos		RTS set-up problem fixed.
SW-65	578444.99	3751494.5	P1707123KKK.pos		OK, multiple top-coil spikes removed
SW-66	578488.98	3751494.3	P1707123PPP.pos		No visible anomaly. OK, multiple top-coil spikes removed
SW-67	578457.93	3751495.9	P1707123LLL.pos		One backtrack deleted, one short line deleted, multiple top-coil spikes removed
SW-68	578476.01	3751510.2	P1707123QQQ.pos		OK, multiple top-coil spikes removed
GPO Cued interrogation					
GPO-01	578217.01	3751318.19	P1707128QQ.pos		Original Label: 33. One redundant line deleted. Multiple bottom coil spikes removed
GPO-02	578224.81	3751345.95	P1707128JJ.pos		Original Label: 10. OK
GPO-03	578217.44	3751357.81	P1707128H.pos		Original Label: 6. Multiple top-coil spikes removed
GPO-04	578222.98	3751323.69	P1707128PP.pos		Original Label: 34. OK
GPO-05	578254.41	3751331.84	P1707128HHH.pos		Original Label: 22. Multiple top-coil spikes removed
GPO-06	578260.56	3751353.38	P1707128T.pos		Original Label: 17. Multiple top-coil spikes removed
GPO-07	578237.27	3751341.00	P1707128FF.pos		Original Label: 28. Multiple top-coil spikes removed
GPO-08	578245.07	3751341.22	P1707128BB.pos		Original Label: 26. Multiple top-coil spikes removed
GPO-09	578227.16	3751337.24	P1707128GG.pos		Original Label: 30. OK
GPO-10	578259.76	3751365.32	P1707128S.pos		Original Label: 16. Multiple top-coil spikes removed
GPO-11	578251.82	3751350.88	P1707128X.pos		Original Label: 15. Multiple top-coil spikes removed
GPO-12	578234.47	3751347.35	P1707128DD.pos		Original Label: 13. Multiple top-coil spikes removed
GPO-13	578229.01	3751353.93	P1707128N.pos		Original Label: 9. Multiple top-coil spikes removed
GPO-14	578247.82	3751364.79	P1707128O.pos		Original Label: 4. Multiple top-coil spikes removed
GPO-15	578238.12	3751361.27	P1707128K.pos		Original Label: 3. Multiple top-coil spikes removed
GPO-16	578263.14	3751329.38	P1707128JJJ.pos		Original Label: 21. Multiple top-coil spikes removed
GPO-17	578220.61	3751364.80	P1707128F.pos		Original Label: 1. Multiple top-coil spikes removed
GPO-18	578218.09	3751336.77	P1707128LL.pos		Original Label: 31. One bottom coil spike removed
GPO-19	578216.69	3751347.31	P1707128KK.pos		Original Label: 7. OK
GPO-20	578252.26	3751321.62	P1707128BBB.pos		Original Label: 37. One bottom coil spike removed
GPO-21	578228.44	3751361.60	P1707131H.pos		Original Label: 2. Multiple top-coil spikes removed
GPO-22	578260.88	3751317.68	P1707128KKK.pos		Original Label: 38.
GPO-23	578239.55	3751319.40	P1707128XX.pos		Original Label: 36. One bottom coil spike removed

ID	Easting	Northing	Event	Second event	Comments
GPO-24	578246.65	3751327.64	P1707128ZZ.pos		Original Label: 23. Multiple top-coil spikes removed
GPO-25	578244.94	3751355.46	P1707128P.pos		Original Label: 12. Multiple top-coil spikes removed
GPO-26	578240.62	3751335.00	P1707128YY.pos		Original Label: 27. OK
GPO-27	578229.33	3751318.27	P1707128UU.pos		Original Label: 35. Multiple spurious points on one line deleted, and the line was split into two
GPO-28	578264.47	3751341.49	P1707128FFF.pos		Original Label: 19. Multiple top-coil spikes removed
GPO-29	578232.93	3751329.85	P1707128VV.pos		Original Label: 29. OK
GPO-30	578250.43	3751342.60	P1707128Y.pos		Original Label: 25. Multiple top-coil spikes removed
GPO-31	578221.97	3751352.41	P1707128I.pos		Original Label: 8. Multiple top-coil spikes removed
GPO-32	578235.35	3751355.46	P1707128L.pos		Original Label: 11. One NS line missing, one top-coil spike removed
GPO-33	578242.56	3751347.25	P1707128AA.pos		Original Label: 14. Multiple top-coil spikes removed
GPO-34	578253.78	3751359.98	P1707128R.pos		Original Label: 5. Multiple top-coil spikes removed
GPO-35	578257.34	3751345.56	P1707128W.pos		Original Label: 18. Multiple top-coil spikes removed
GPO-36	578258.66	3751337.02	P1707128GGG.pos		Original Label: 20. Multiple top-coil spikes removed
GPO-37	578249.01	3751336.22	P1707131F.pos		Original Label: 24. Multiple top-coil spikes removed
GPO-38	578217.04	3751330.51	P1707128OO.pos		Original Label: 32. OK
GPO Full coverage					
Full			P1707130U.pos	P1707130W.pos	Over 200 top-coil spikes automatically removed and additional ones manually removed A number of short lines were deleted
Full			P1707130Y.pos	P1707130AA.pos	
Full			P1707130CC.pos	P1707130GG.pos	
Full			P1707130II.pos	P1707130LL.pos	
Full			P1707130QQ.pos	P1707130OO.pos	
South-West Full coverage					
Full			P1707131K.pos	P1707131M.pos	124 top-coil spikes automatically removed
Full			P1707131O.pos	P1707131N.pos	
Full			P1707131R.pos	P1707131T.pos	
Full			P1707131V.pos		